Infants' Selective Social Learning

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The Impact of Informants' Knowledge States and Familiarity on Infants' Reception and Use of Information within the Second Year of Life

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For all companions of infants' inner potentials.

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Zusammenfassung

Die Aufrechterhaltung und Weiterentwicklung der menschlichen Kultur fußt insbesondere auf der Weitergabe und Aneignung des Wissens über die Welt, das in Form von Informationen von einer Menschengeneration zur nächsten übertragen wird. In der vorliegenden Dissertation werden Aspekte der ontogenetischen Ursprünge dieses sozialen Informations- und Wissenstransfers untersucht. Der Fokus liegt dabei auf Kleinkindern im zweiten Lebensjahr. In dieser Phase ihres Lebens handeln Kinder bereits als aktiv Lernende in ihrer sozialen Umwelt, in welcher sie bestimmte Informanten als zuverlässige Informationsquellen auswählen. Es wurden vier Studienreihen durchgeführt mit dem Ziel zu untersuchen, inwiefern sich zentrale Aspekte von Informanten, insbesondere deren Wissensstand und Vertrautheit, auf die Präferenz von Kleinkindern bevorzugt Informationen von bestimmten Informanten zu empfangen und zu nutzen, auswirken.

In Studienreihe 1 wurde überprüft, ob 14-monatige Kleinkinder hinsichtlich des Wissensstandes von Informanten, basierend auf deren lokaler Expertise, selektiv sind. Die Hypothese der lokalen Expertise resultiert aus Laborstudien, welche die Präferenz von Kleinkindern aufdeckten, bevorzugt Informationen von einem fremden Testleiter, anstelle von ihren vertrauten Eltern, zu empfangen und zu nutzen (z.B. Stenberg, 2009). Allerdings ist diese Hypothese bislang in keiner Studie durch eine Manipulation des Ortes des Experiments zufriedenstellend untersucht worden. Daher wurden im Rahmen der ersten Studienreihe zwei Studien entworfen, welche jeweils mit einem vertrauten (ein Elternteil) und einem fremden (ein Testleiter) Informanten sowie an einem vertrauten (das Zuhause der Kleinkinder) und an einem fremden (das Labor) Ort durchgeführt wurden. In Studie 1a wurde das soziale Referenzieren der Kleinkinder in einer Explorationsaufgabe, in der die Kleinkinder emotionale Informationen über neue Objekte präsentiert bekamen, untersucht. In Studie 1b wurde dagegen das Imitationsverhalten der Kleinkinder in einer Imitationsaufgabe, in der die Kleinkinder neue Handlungen demonstriert bekamen, gemessen. Im Ergebnis beider Studien zeigte sich, dass das soziale Lernverhalten der Kleinkinder in keinem der beiden Paradigmen mit der Hypothese der lokalen Expertise erklärt werden kann. In beiden Paradigmen und Orten empfingen die Kleinkinder mehr Informationen vom fremden als vom vertrauten Informanten, zeigten jedoch keine konsistente Präferenz für einen der Informanten bei ihrer Informationsnutzung. Stattdessen erkundeten die Kleinkinder die Objekte mehr, wenn diese von dem vertrauten im Gegensatz zum fremden Informanten präsentiert wurden (Studie 1a) und imitierten spontan mehr die vorgemachte Handlung des vertrauten als die des fremden Informanten (Studie 1b).

Um die Selektivität von Kleinkindern hinsichtlich des Wissensstandes von Informanten weiter zu untersuchen, wurde Studienreihe 2 – bestehend aus zwei Längsschnittstudien – konzipiert und durchgeführt. Beide Studien dieser Studienreihe fokussierten auf die selektive Nutzung des Wissensstandes von Informanten basierend auf deren visueller Perspektive in Versteckspielen. Hierfür gaben zwei Informanten gegensätzliche Informationen über den Ort eines versteckten Objektes, wobei sich beide Informanten offensichtlich in Bezug auf ihr Wissen über den Ort des Objektes unterschieden: Während ein Informant zusah, wie ein Objekt versteckt wurde (wissender Informant), sah der andere Informant weg (unwissender Informant). In Studie 2a, folgten die Kinder weder im Alter von 14 noch im Alter von 19 Monaten häufiger den referenziellen Hinweisen (physische Marker) des wissenden als den Hinweisen des unwissenden Informanten. Basierend auf einem direkten Vergleich beider Altersgruppen zeigte sich jedoch eine Tendenz dahingehend, dass die Studienteilnehmenden mit 19 Monaten, im Vergleich zu ihrer Teilnahme fünf Monate zuvor, den Hinweisen des wissenden Informanten mehr folgten als den Hinweisen des unwissenden Informanten. In Ergänzung dazu zeigte sich in dem modifizierten Versteckspiel in Studie 2b, dass die Kinder im Alter von 20 Monaten, nicht jedoch im Alter von 14 Monaten, die referenziellen Hinweise (Zeigegesten) des wissenden Informanten signifikant bevorzugten. Demnach liefern die Ergebnisse beider Studien umfassende Belege für eine Entwicklung hinsichtlich der selektiven Nutzung des Wissens anderer in einem Versteckspiel bei Kindern im zweiten Lebensjahr. Darüber hinaus verdeutlichen die Ergebnisse von Studie 2a, dass sich bei Kindern innerhalb des zweiten Lebensjahres die Fähigkeit entwickelt, physische Marker als abstrakte referenzielle Hinweise für den Ort eines versteckten Objektes zu nutzen. Zudem unterstützen die Ergebnisse der Studie 2b die bisherigen Befunde anderer Studien im Hinblick auf die kindliche Fähigkeit der Nutzung von Zeigegesten als konkrete referenzielle Hinweise. Zusammengenommen liefert Studienreihe 2 bedeutende empirische Belege, sowohl hinsichtlich der Entwicklung der vorsprachlichen Kommunikation von Kleinkindern als auch hinsichtlich der Entwicklung ihrer Fähigkeit relevante Informationen durch das Teilen des Wissens anderer auszuwählen. Ein Vergleich zwischen den Ergebnissen von Studienreihe 1 und Studienreihe 2 zeigt, dass das soziale Lernverhalten von 14-monatigen Kleinkindern nicht durch den Wissensstand der Informanten beeinflusst wurde, weder in Bezug auf die lokale Expertise der Informanten, noch in Bezug auf deren visuelle Perspektive.

In Studie 3 wurden die aus Studienreihe 1 entstandenen Fragen nach der Selektivität von Kleinkindern hinsichtlich der Vertrautheit von Informanten bei der Suche und Nutzung von Informationen aufgegriffen. Zu diesem Zweck gaben in dem Versteckspiel von Studie 3 ein

vertrauter und ein fremder Informant gegensätzliche Informationen über den Ort eines versteckten Objektes, wobei beide Informanten den Ort des Objektes wussten. Die Ergebnisse liefern wichtige Belege dafür, dass Kinder im Alter von 14 und 20 Monaten bevorzugt von fremden im Vergleich zu vertrauten Informanten Informationen suchen. Keine der beiden Altersgruppen zeigte jedoch eine konsistente Präferenz für einen bestimmten Informanten bei der Nutzung der referenziellen Hinweise der Informanten (Zeigegesten). Dennoch verhielt sich eine signifikante Anzahl von Kleinkindern im Alter von 14 Monaten selektiv hinsichtlich der Vertrautheit der Informanten, indem diese Kinder entweder eine Präferenz für die Nutzung der Informationen des vertrauten oder des fremden Informanten zeigten. Im Unterschied dazu ergab sich für Kleinkinder im Alter von 20 Monaten eine identische Anzahl von selektiven und nicht selektiven Kleinkindern, was unterstreicht, dass die Vertrautheit der Informanten keinen Einfluss auf die Informationsnutzung der Kinder dieses Alters hat. Der Vergleich zwischen Studie 3 und Studienreihe 1 deutet auf eine Konsistenz hinsichtlich des bevorzugten Informationsempfangs von fremden im Gegensatz zu vertrauten Informanten hin. Dadurch, dass die Informationsnutzung der Kleinkinder weder von einer konsistenten Präferenz für den vertrauten noch für den fremden Informanten gekennzeichnet war, unterscheidet sich das Muster der Informationsnutzung in der gegenwärtigen Dissertation von dem Muster des Informationsempfangs. Diese Ergebnisse offenbaren eine Lücke bei der Selektivität von Kleinkindern zwischen dem Empfang und der Nutzung von Informationen.

Nachdem in den vorherigen Studien das Verhalten der Kinder für die gesamte Altersgruppe erforscht wurde, werden in Studienreihe 4 schließlich inter-individuelle Unterschiede im sozialen Lernen der Kleinkinder in den Blick genommen. Der Fokus liegt hierbei auf dem Zusammenhang zwischen der Qualität der Eltern-Kind Interaktion und dem sozialen Lernen der Kleinkinder von vertrauten und fremden Informanten. In jeder der drei Studien dieser Studienreihe wurde die Sensitivität der Eltern sowohl hinsichtlich ihres aktiven Engagements basierend auf dem Aufmerksamkeitsfokus ihrer Kinder (Aufrechterhaltung von Aufmerksamkeit) als auch hinsichtlich ihrer kontingenten, unterstützenden und warmen Reaktionen auf die Signale und Handlungen ihrer Kinder (Warme Sensitivität) während einer objekt-basierten Freispielsituation untersucht. In der Aufgabe des sozialen Referenzierens (Studie 4a) zeigten sich positive Zusammenhänge zwischen der Sensitivität der Eltern und dem Informationsempfang der Kleinkinder sowohl von vertrauten als auch von fremden Informanten: Je sensitiver die Eltern mit ihren Kleinkindern interagierten, desto mehr Informationen empfingen die Kleinkinder von beiden Informanten. Dieses Ergebnis hebt die Bedeutung der elterlichen Sensitivität für das Vertrauen der Kleinkinder in das Sammeln von

Informationen über die Welt von einer Vielzahl sozialer Partner hervor. Die elterliche Sensitivität wirkte sich jedoch nicht auf die Nutzung der emotionalen Informationen bei der Erkundung der neuen Objekte aus. Im Hinblick auf das Imitationsparadigma (Studie 4b) wurden keine selektiven Effekte zwischen der Sensitivität der Eltern und dem Blick- und Imitationsverhalten der Kleinkinder gefunden. Im Gegensatz dazu zeigten sich im Rahmen eines Versteckspiels (Studie 4c) verschiedene Muster der Selektivität: Während Kleinkinder weniger sensitiver Eltern selektiv waren hinsichtlich der Suche von Informationen und der Nutzung der referenziellen Hinweise von den vertrauten und fremden Informanten, waren Kleinkinder sensitiverer Eltern nicht selektiv. Kleinkinder weniger sensitiver Eltern zeigten demnach eine Präferenz für fremde gegenüber vertrauten Informanten bei der Informationssuche, was möglicherweise auf das Misstrauen von Kleinkindern weniger sensitiver Eltern in ihre Eltern als zuverlässige Informationsquelle hindeutet. Darüber hinaus zeigte eine signifikante Anzahl an Kleinkindern weniger sensitiver Eltern eine Präferenz bei der Nutzung der referenziellen Hinweise für die fremden oder die vertrauten Informanten, wohingegen lediglich eine geringe Anzahl an Kleinkindern weniger sensitiver Eltern keine Präferenz zeigte. Die Ergebnisse dieser vierten Studienreihe deuten demnach darauf hin, dass die elterliche Sensitivität in der Eltern-Kind Interaktion, in Abhängigkeit von der Lernsituation, im Zusammenhang mit der Selektivität von Kleinkindern beim Lernen von vertrauten und fremden Informanten steht.

Abschließend wird ein Modell der fortlaufenden Bewertung der Reliabilität von Informanten vorgestellt, welches eine Möglichkeit darstellt, die wesentlichen Ergebnisse der vorliegenden Dissertation zusammenzuführen und zu erklären. In dem Modell wird vorgeschlagen, dass die Bewertung der Reliabilität von Informanten durch Kleinkinder auf einem kontinuierlichen Prozess, einschließlich des Empfangs, der Verarbeitung und der Nutzung von Informationen, basiert. In diesem Modell ist die Fähigkeit, bei der Problemlösung in sozialen Lernsituationen auf relevante Informationen zu fokussieren, ein zentraler Aspekt. Die vorliegenden Studien liefern empirische Hinweise darauf, dass das Alter der Kinder und die Sensitivität ihrer Eltern Faktoren sein könnten, welche diese Fähigkeit formen. Dieses Modell gilt es in der zukünftigen Forschung zu überprüfen, um dadurch zu einem tieferen Verständnis für das soziale Lernverhalten von Kleinkindern und ihren zugrundeliegenden Motivationen zu gelangen, anhand derer die Kleinkinder Informanten auswählen, um sich aktiv Wissen über die sie umgebende Welt anzueignen und damit die menschliche Kultur aufrechtzuerhalten und weiterzuentwickeln.

Summary

The maintenance and further development of human culture is based in particular on the transmission and acquisition of knowledge about the world via the transference of information from one human generation to the next. In this dissertation, we investigate aspects of the ontogenetic origins of this social transfer of information and knowledge. In doing so, we focus on infants in their second year of life, who are already known to be active learners in a social environment, in which they select informants whom they perceive to be the most reliable sources of information. To investigate whether certain core aspects of informants, in particular their knowledge states and familiarity, impact infants' selectivity when receiving and using informants' information, we conducted four study sets.

In Study Set 1, we investigated whether infants at 14 months of age were selective due to informants' knowledge states based on the informants' local expertise. The local-expertise hypothesis derived from laboratory studies discovering infants' preference to receive and use information provided by an unfamiliar experimenter rather than by their familiar parents (e.g. Stenberg, 2009). However, none of the existing studies sufficiently investigated this hypothesis by varying the location of the experiment. Therefore, we designed two studies each consisting of a familiar (i.e. the infant's parent) and an unfamiliar (i.e. the experimenter) informant and each conducted in both a familiar (i.e. the infant's home) and an unfamiliar (i.e. the laboratory) location. In Study 1a, infants' social referencing behavior was measured in an exploration task, in which emotional information about a novel object were provided for infants. In Study 1b, we investigated infants' imitative behavior in the imitation task, in which novel actions were demonstrated for infants (Study 1b). Our results from both studies show that infants' social learning behavior cannot be explained by the local-expertise hypothesis. Infants in both paradigms and both locations received more information from the unfamiliar than the familiar informant, and they did not show a consistent preference for any of the informants when using their information. Instead, infants explored the objects more when presented by the familiar than by the unfamiliar informant (Study 1a), and they spontaneously imitated the action more when modeled by the familiar rather than the unfamiliar informant (Study 1b).

To further investigate infants' selectivity due to informants' knowledge states we designed and conducted Study Set 2, which consisted of two longitudinal studies. In both studies we focused on infants' selective use of informants' knowledge states based on their visual perspective in hiding-finding games. For this purpose, two informants provided conflicting information about the location of a hidden object while obviously differing in their knowledge of the object's location: Whereas one informant observed the hiding (knowledgeable

informant), the other looked away (ignorant informant). In Study 2a, neither infants at 14 months of age nor at 19 months of age followed the referential cues (i.e. physical markers) of a knowledgeable informant more than that of an ignorant informant. However, given a direct comparison of both age groups, the older participants tended to prefer the referential cues provided by a knowledgeable over an ignorant informant more than the same participants did about five months earlier. Complementarily, in the adjusted hiding-finding game of Study 2b, infants at 20 but not at 14 months of age significantly preferred to use the referential cues (i.e. pointing gestures) provided by a knowledgeable rather than an ignorant informant. Thus, the results of both studies provided indications for a development of infants' selective use of others' knowledge in a hiding-finding game within the second year of life. Moreover, whereas Study 2a emphasizes the developing ability of infants within their second year of life to use a physical marker as an abstract referential cue, Study 2b supports the results of previous studies about infants' ability to use a pointing gesture as a concrete referential cue. Taken together, Study Set 2 contributes important empirical evidence concerning the development of infants' prelinguistic communication and the ability to select relevant information by sharing others' knowledge. When comparing the results of Study Set 1 and Study Set 2, we conclude that the 14-month-olds' social learning behavior was not affects by the informants' knowledge state, neither in terms of the informants' local expertise, nor in terms of the informants' visual perspective.

Study 3 took up and further investigated the question raised from Study Set 1, that is, infants' selectivity due to the informants' familiarity when looking for und using information. In the hiding-finding game of Study 3, a familiar und an unfamiliar informant provided conflicting information about the location of a hidden object, wherein both informants were knowledgeable about the object's location. The results of this longitudinal study provide important evidence for the preference of infants at 14 and 20 months of age to look for information from unfamiliar informants more than from familiar informants. In contrast, infants at both ages did not show a preference for a certain informant when using the informants' referential cues (i.e. pointing gestures). However, a significant number of infants at 14 months of age were nevertheless selective in terms of the informants' familiarity by demonstrating either a preference to use the familiar informant's or the unfamiliar informant's information. Differently, for infants at 20 months of age, the number of selective infants was equal to the number of non-selective infants, emphasizing that the informants' familiarity did not affect the information use of infants at this age. Regarding the comparison of the results of Study 3 and the first study set, there is a consistency in terms of infants' information reception from the unfamiliar as opposed to the familiar informant. Given that infants' information use was neither characterized by a consistent

preference for the familiar nor the unfamiliar informant in both Study Set 1 and Study 3, the pattern of infants' information use in the current dissertation was different to the pattern of infants' information reception. These findings reveal a gap of infants' selectivity between their reception and use of information.

Finally, whereas the previous studies investigated infants' social learning behavior for the whole age group, Study Set 4 focuses on inter-individual differences by looking for correlations between the quality of parent-infant interaction and 14-month-olds' social learning from familiar and unfamiliar informants. In particular, all three studies of this study set observed the parents' sensitivity concerning their active engagement based on their infants' focus of attention (Maintaining Attention), as well as concerning their contingent, supportive, and warm reactions to their infants' signals and actions (Warm Sensitivity) in an object-based free play situation. In the social referencing task (Study 4a), we found positive interrelating effects between parents' sensitivity and infants' information reception from both the familiar and unfamiliar informant: The more sensitively parents interacted with their infants, the more information infants received from both informants. This result highlights the importance of parents' sensitivity for infants' confidence in gathering information about the world from familiar and unfamiliar social partners. However, parents' sensitivity was not related to infants' use of emotional information when exploring a novel box. Regarding the imitation paradigm (Study 4b), no effects were found between parents' sensitivity and infants' looking and imitative behavior. In contrast, based on a hiding-finding paradigm (Study 4c), we found different patterns of selectivity: Whereas infants of less sensitive parents were selective when looking for information and using the referential cues given by the familiar and unfamiliar informants, infants of more sensitive parents were not selective. In particular, infants of less sensitive parents showed a consistent preference to look for information from the unfamiliar over the familiar informants, possibly indicating those infants' mistrust in their parents as reliable sources of information. Moreover, a significant number of infants of less sensitive parents demonstrated a preference to either use the unfamiliar or the familiar informants' referential cues, whereas only a few number of infants of less sensitive parents did not show any preference. The results of our fourth study set therefore indicate that, depending on the learning task, the parents' sensitivity in the parent-infant interaction is interrelated with infants' selectivity when learning from familiar and unfamiliar informants.

Consequently, we present a model of infants' ongoing evaluation of informants' reliability, representing a possibility to incorporate and explain our main results. In the model we suggest that infants' evaluation of informants' reliability is based on a continuous process including the

reception, processing, and use of information. A core aspect in this process is the ability to focus on relevant information when solving a problem in a social learning situation. We found empirical indications in our studies that infants' age and the parents' sensitivity might be factors shaping this ability. This model could be investigated in future research to develop a deeper understanding of infants' social learning behavior and their underlying motivation when selecting informants to actively acquire knowledge about the world around them and, therefore, to maintain and to further develop human culture.

1. Introduction

Infants have an innate motivation to learn about the world around them (Carlton & Winsler, 1998; Deci, 1975). On the one hand, infants are motivated to directly experience the world on their own. For instance, they inspect a tree with all the senses they have, that is to say, infants touch a tree in order to experience what the tree feels like, look at it and its details, smell the scent of the bark and the leaves, listen carefully to the rustling leaves and chirping birds, and play around with a branch to investigate its physical properties. In this sense, infants are little researchers who construct their knowledge about the world based on their own experiences, as is decidedly emphasized in Piaget's theory about infants' cognitive development (Piaget, 1962, 1997). On the other hand, infants use others' information to learn about the world. In keeping with our example, infants are motivated to imitate others' actions when they observe others demonstrating the noises it makes when knocked against the trunk, infants are more likely to approach a moving caterpillar on a leaf after receiving positive emotions from others as reinsurance to the infants' initial uncertainty about the unknown animal, and infants can follow others' pointing gestures to an apple on a tree to get information about where to find such rewards in their environment. This second type of learning about the world – by using information provided by others – is called *social learning*.

1.1 Social Learning in Infancy

The concept of social learning is used in various ways, as such, various definitions exist in the literature regarding the meaning of this term (Wals & van der Leij, 2009; see Reed et al., 2010, for a discussion of definitions of social learning). When we talk about social learning in this dissertation, we focus on a core process of "learning by individuals that takes place in social settings and/or is socially conditioned" (Parson & Clark, 1995). This perspective demonstrates that learning "does not take place in a vacuum but rather in rich social contexts" (Wals & van der Leij, 2009, p. 18). Vygotsky's theory about infants' cognitive development takes up this social side of infants' learning. This theory emphasizes the importance of infants being surrounded by others to provide for their acquisition of certain capabilities and knowledge (Vygotsky, 1978; Vygotsky, Hanfmann, & Vakar, 1962). Infants are social beings whose cognitive development is determined by the socio-cultural context in which they grow up. In this context, infants benefit from knowledgeable others when they make use of the information provided. Similar to this perspective, Bandura compressed his thoughts about infants' development into a social learning theory (Bandura, 1971; Bandura & Walters, 1963). In this

theory, the main developmental mechanisms are observational learning and the imitation of models and their actions, which reflect the biggest part of humans' learning. According to the theoretical assumptions, social context is the most influential factor in infants' cognitive development. However, Bandura emphatically states that the social environment is also affected by the learner's behavior: "Behavior partly creates the environment and the resultant environment, in turn, influences behavior. In this two-way causal process the environment is just as influenceable as the behavior it controls." (Bandura, 1971, p. 40) This mutual determinism can be described as a "reciprocal interaction" (Bandura, 1971, p. 39) between infants and their social environment, and combines both Piaget's theory and Vygotsky's theory. Whereas in Piaget's theory infants are described as active seekers of information and knowledge, they deeply depend on their social environment in Vygotsky's theory. Thus, Bandura's social learning theory reflects a "happy marriage" of these two foundational theories (Koenig & Sabbagh, 2013, p. 399). Therefore, when infants learn, they do so in a co-constructive process and active co-operation with the people around them. Within the second year of life infants start to create a sense of others as cooperative partners, as is reflected by shared intentionality when solving a problem via social learning (Tomasello, 2009). Indeed, this is what makes humans unique in comparison to other primates (Rakoczy & Tomasello, 2008; Searle, 1983; Tomasello, 2009). This dissertation was designed and conducted to further investigate the ontogenetic origins of this species-unique phenomenon of social learning. More specifically, this project was motivated by the goal to further develop our understanding of how infants actively take into account and make use of the information provided in their social environment – one of the fundamental aspects of living human cultures and their achievements (Tomasello, 2009).

1.1.1 Information Transfer as a Core Process of Social Learning

As highlighted previously, a prerequisite and crucial advantage of human cultures is to transfer knowledge from one generation to another or to the next generation. An important prerequisite here is that humans grow up in social environments. This means that starting from birth, infants are accompanied by other humans who have often already experienced a lot of the world and are therefore able to provide infants with useful information. There are situations in infants' everyday lives, in which they do not have enough information to solve problems and therefore depend on receiving information from others. According to theories and empirical evidence about information processing, infants behave like "active problem-solvers" (Whitebread, 1999, p. 489) and, as such, they are highly motivated to receive and use others'

information (Harris, 2012; Harris & Koenig, 2006; Harris & Lane, 2013; Poulin-Dubois & Brosseau-Liard, 2016; Vygotsky et al., 1962). Information can be defined as a subset of knowledge that is needed by a person or a group in a concrete situation to solve a problem (Kuhlen, 1990, p. 13).

The Organon Model

To better demonstrate the process of information transference, we introduce a basic model of communication called the *Organon model* (Bühler, 1999). According to this model, in order for one person successfully transfer information to another, the *receiver* (i.e. the recipient) needs to perceive the *organum* (i.e. the medium) by which the *sender* (i.e. the informant) provides information about the *things* (i.e. the entity) in the world (see Figure 1). In this model, the organum is defined as the sensual perceivable by which information will be transferred (e.g. use of language or a pointing gesture), whereas the things can be, for example, objects, actions or events in the world about which information will be transferred (Bühler, 1999, p. 25).

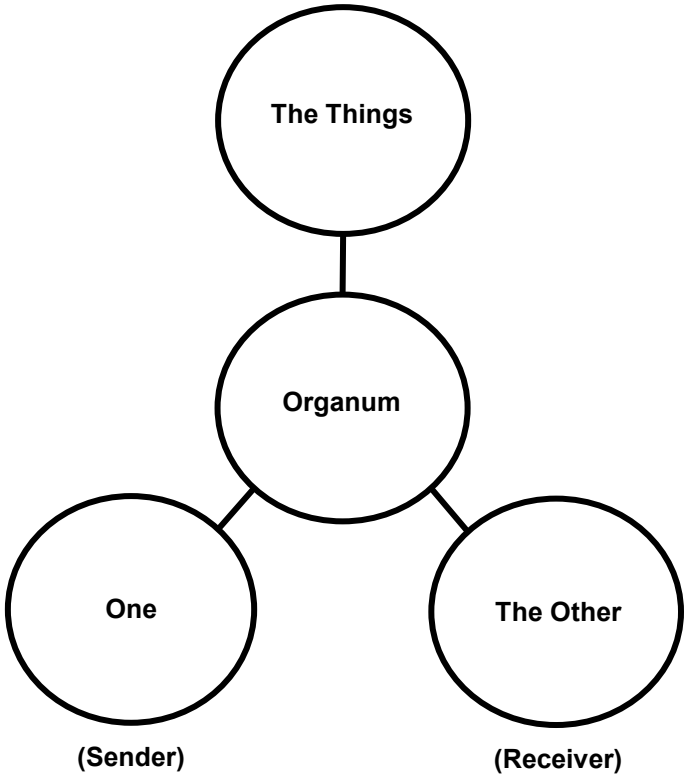

Figure 1. The Organon model as a basic model of social communication.

The Adapted Model

We adapted this basic model in order to further depict the process of transferring information from an *informant* to a *recipient* (see Figure 2). The adapted version of the Organon model expatiates the *context* of a social learning situation depicted by the dashed circle that borders the model. The context focuses on the location or framework in which an information transfer takes place. The starting point of the transfer of information from an informant to a recipient is the informant's possession of information about something in the world, meaning that the informant *has information*. If someone is motivated to share her/his knowledge with others, the knowledge provider acts as an informant with a communicative intention (Sperber & Wilson, 1995). Communicative intention reflects a natural feature of human communication and it represents someone's desire to transfer information: "I want you to know" (Tomasello, Carpenter, & Liszkowski, 2007, p. 708). Thus, the informant intends to share a certain knowledge state by *sending information* to a recipient.

The recipient, in turn, *receives information* about the entity by paying attention to the informant and in so doing, to the medium by which and the entity about which the informant provides information. The recipient's attention is an important prerequisite for the success of a social learning process (Bandura, 1971). The reception of others' provided information, in such a triadic interaction (i.e. the recipient, the sender, and the entity), can be better understood by using the concept of intersubjectivity, that is, "the sharing of subjective states by two or more individuals" (Scheff, 2006, p. 196). Newborns are already involved in a so-called "primary intersubjectivity", which refers to dyadic interactions with other individuals, for example, when interacting face-to-face with adults (Trevarthen, 1979, p. 321; Carpenter, Nagell, Tomasello, Butterworth, & Moore, 1998). Later on, at around 9 months of age, infants develop a sense of a "secondary intersubjectivity" or "cooperative awareness" (Trevarthen & Hubley, 1978, p. 183) in triadic interactions. The awareness that others and oneself intentionally focus on the same thing in the world is well known as "joint attention", which includes the sharing, following, and directing of others' attention (Carpenter, Nagell et al., 1998, p. 1). Irrespective whether infants follow or direct others' attention, there is a shared focus of attention. The interactive expression of such a shared focus of attention over some period of time (at least a few seconds) is called "joint engagement" and can be observed by infants' gaze switches between the informant and the entity (e.g. an object) (Carpenter, Nagell et al., 1998, p. 5). Thus, infants' joint engagement in an entity of mutual interest with an informant is important for the process of receiving others' information in a triadic interaction. The most directly observable measurement of attention is via the infants' visual attention (Carpenter, Nagell et al., 1998).

Consequently, not only are infants "biologically prepared to perceive peoples' communicative behavior" (Legerstee, Markova, & Fisher, 2007, p. 298), they also start quite early to understand how to benefit from a triadic interaction in order to "share experiences about the world" (Legerstee et al., 2007, p. 296; Trevarthen, 1979).

Moreover, this information is contained in and transferred through the *medium*. Bühler (1999) himself further developed and specified his Organon model by focusing on language as the medium by which information is transferred. However, information is not only transferred verbally by using language but also by using non-verbal communicative signals. To enrich verbally provided information by non-verbal communicative signals is especially important when infants are recipients due to their still developing language abilities. Infants need to be able to understand and make use of the medium in order to infer and use the information about an *entity* (e.g. an object, an action, or a situation). This *use of others' information* is the last step of such a social transfer of information. Depending on the situation, infants' information use can be observed when infants regulate their behavior in accordance with the information provided by an informant.

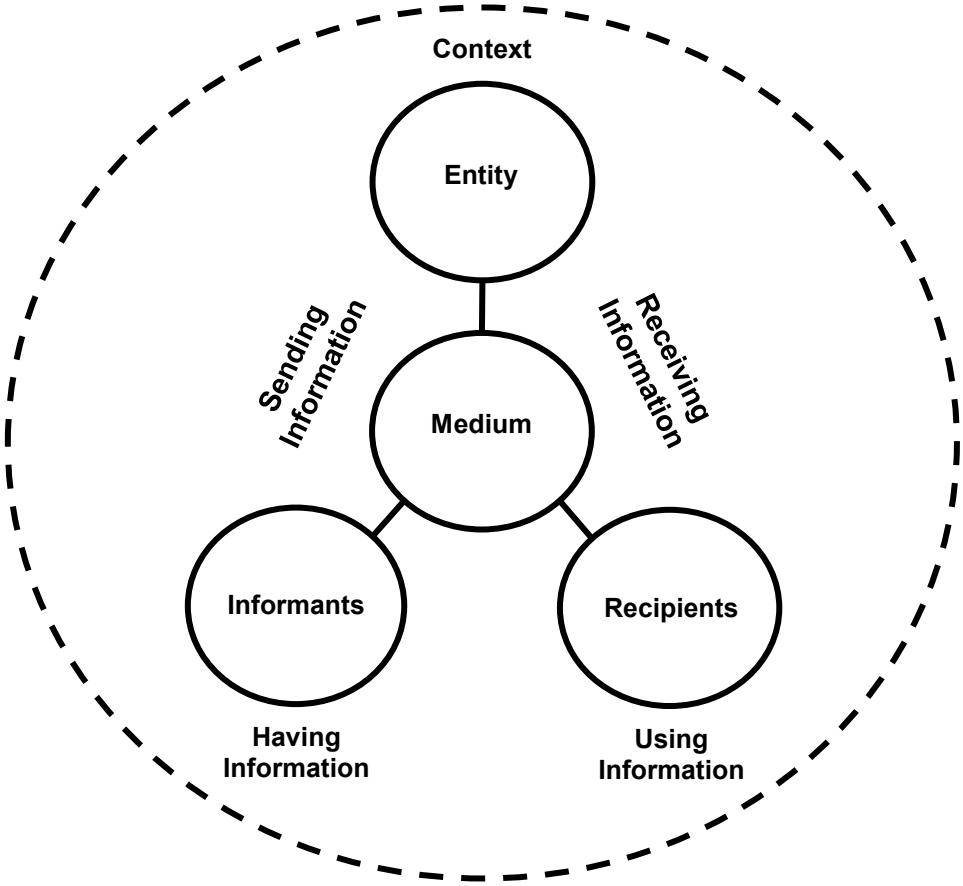

Figure 2. The adapted version of the Organon model.

1.1.2 Different Forms of Infants' Social Learning

The previously reported process of transferring information can be realized through different forms of social learning. In the subsequent sections we will mention the core features and empirical evidence of three forms of social learning: social referencing or learning based on others' emotional expressions, imitation or learning based on others' modeled actions, and infants' learning based on others' referential cues.

Social Referencing

Imagine an infant facing an object that s/he has never seen before. The novelty of the object implies to some extent an ambiguous or uncertain situation for the infant, meaning that the infant does not know how to evaluate this object. However, a social partner next to the infant provides information about it by displaying positive emotions (i.e., joyful and excited facial and verbal expressions) or negative emotions (i.e., disgusted and derogatory facial and verbal expressions). This information offers a possibility for infants to learn about the object's valence. Fortunately, based on infants' preference to look at faces, infants are biologically prepared to take others' facial expressions into account (Bowlby, 1969; Thomas & Jones-Molfese, 1977). When 1-month-old infants look at faces, they tend to look at the perimeter, for example, a person's chin or hairline, which is characterized by a relatively high contrast to the background. However, by two months of age, infants already recognize faces in much more detail and pay attention to both the shape and core features, especially the eyes and the mouth (Maurer & Salapatek, 1976). Thus, infants are well prepared to make use of others' facial expressions from very early on. This phenomenon is called *social referencing* by which others' facial expressions are used as evaluative information about the things in the world (Feinman, Roberts, Hsieh, Sawyer, & Swanson, 1992; Hornik, Risenhoover, & Gunnar, 1987; Stenberg, 2009). Social referencing can be defined as the receipt and use of others' emotional reactions to regulate one's behavior in novel, ambiguous, or possibly threatening situations (Feinman, 1982; Klinnert, Emde, Butterfield, & Campos, 1986).

Social referencing is based on infants' ability to recognize and understand others' emotional expressions. That 3.5-month-old infants already recognize the difference between happy and sad emotions is empirically proven by their looking differently at their mothers' videotaped emotions (Kahana-Kalman & Walker-Andrews, 2001; Montague & Walker-Andrews, 2002). Moreover, infants at 4 to 7 months of age are able to distinguish between happy and surprised emotions (Serrano, Iglesias, & Loeches, 1993; Walker-Andrews & Dickson, 1997). More specifically, infants looked at pictures of faces displaying surprised emotions for a longer

amount of time than to previously shown pictures of faces displaying happy emotions. That means, based on the mechanisms of habituation (i.e. decrease of attention to repeated stimuli) and dishabituation (i.e. increase of attention to new stimuli), infants evaluated the surprised-emotion stimuli as novel, and thus different, compared to the happy-emotion stimuli. Moreover, at 7 months of age infants discriminate between fearful and angry emotions when measuring participants' brain waves (Kobiella, Grossmann, Reid, & Striano, 2008). At this age, infants start to ascribe meaning to the emotional information. For instance, if infants were presented with a congruent (e.g., smiling face and bubbly voice) and an incongruent (e.g., sad face and bubbly voice) scenario of emotions, participants paid more attention to the congruent condition (Walker-Andrews & Dickson, 1997). From 8 to 12 months of age and onwards, infants are able to relate facial and vocal emotional expressions to events in their environment (Siegler, DeLoache, & Eisenberg, 2011). Thus, according to several studies (Carver & Vaccaro, 2007; Hertenstein & Campos, 2004; Moses, Baldwin, Rosicky, & Tidball, 2001; Mumme, Fernald, & Herrera, 1996; Saarni, Campos, Camras, & Witherington, 2006), infants at 12 and 14 months of age regulate their behavior in accordance with the emotional information displayed by their mother. That is, infants approach a novel object or person when their mother displayed positive emotions and they avoid doing so when she displayed negative emotions. There is still more evidence for 12- to 18-month-old infants' ability to use others' emotions (Klinnert, 1984; Klinnert et al., 1986; Moses et al., 2001; Mumme & Fernald, 2003; Repacholi, 1998; Rosnay, Cooper, Tsigaras, & Murray, 2006; Sorce, Emde, Campos, & Klinnert, 1985). In the study conducted by Repacholi (1998), for example, an experimenter expressed happy emotions when looking and putting her hand into one box, and she expressed disgust when looking and putting her hand into a second box. Results indicated that 14- and 18-month-old infants preferred to search for the object in the 'happy-emotion' box, meaning that both age groups correctly associated the displayed emotions to the content of the two boxes (see also Repacholi, 2009). Consequently, infants understand and make use of the directedness of emotional valences to certain events in their environment.

Infants at 12 months of age usually approach a novel object and an unfamiliar person when the mother displayed positive emotions and they avoid doing so when the mother displayed fearful emotions (Carver & Vaccaro, 2007; Moses et al., 2001; Saarni et al., 2006). Moreover, infants at this age are able to infer the meaning of their mothers' tone of voice. When 12-month-old participants were presented with a novel toy and their mothers' neutral, happy, or fearful tone of voice without seeing their mothers' face, infants were more cautious in the condition when the mother expressed a fearful tone of voice as opposed to a neutral tone of voice (Mumme

et al., 1996). The happy vocal signal had no effect. Moreover, at 14 months of age, infants' touching behavior concerning a toy was affected by their mother's emotional information even after an hour delay (Hertenstein & Campos, 2004). For an overview of infants' social referencing abilities, see Siegler et al. (2011). To sum up, infants at around their first year of life are able to guide their own behavior in accordance with others' emotional information in ambiguous or uncertain situations.

Observational Learning and Imitation

In order to become a member of their cultural group, infants learn many things via observation, that is by absorbing information provided by the people around them (Bandura, 1971; Bandura & Walters, 1963; Harris, 2012; Harris & Koenig, 2006; Harris & Lane, 2013; Vygotsky et al., 1962). Observational learning, in general, and imitation, in particular, are supposed to be more efficient than, for example, trial and error learning, and are important tools by which children learn a wide range of certain culture-specific behaviors (Abravanel & Sigafoos, 1984; Parker, 1993; Piaget, 1962). Infants' ability and motivation to imitate others is present from very early on (Barr, Dowden, & Hayne, 1996). Already 12 to 21 days after birth, infants mimic the facial expressions of others (Meltzoff & Moore, 1977, 1989; Ray & Heyes, 2011; but see Jones, 2009, for a critical review of these results). For example, after newborns watched an adult slowly and repeatedly stick out her/his tongue, newborns often copied the motion by sticking out their own tongue (Meltzoff & Moore, 1977). In the middle of the first year of life, infants are able to learn new facts about objects by emulating others' actions (Barr et al., 1996; Hofstein & Siddiqui, 1993). That is, they copy the end states of actions without using the demonstrated manner (Call, Carpenter, & Tomasello, 2005). To copy the demonstrated manner, however, is a crucial prerequisite of imitation (Tennie, Call, & Tomasello, 2006). Given this definition, infants begin to imitate others' object-related actions at around their first birthday, as we will present in more detail in section 1.1.3.

Note that when reporting and investigating infants' imitative behavior in the current dissertation, we consciously focus on the imitative behavior as the process of copying the end state and manner of a modeled action. To what extent infants indeed draw inferences about a model's mental state when performing an action, or rather, a model's intention as the combination of her/his goals and means (Tomasello, Carpenter, Call, Behne, & Moll, 2005), is not the focus when examining infants' imitative behavior.

Learning Based on Referential Cues

Human beings communicate with each other in a variety of linguistic and prelinguistic ways which are socially learned and contain intersubjectively shared symbols (Tomasello et al., 2007). When communicating with human infants, adults often make use of prelinguistic cues (e.g. gestures for greeting, joking, teasing, or indicating). An important prelinguistic cue is a human's pointing gesture which is typically performed by an extended index finger towards a referent (Behne, Carpenter, & Tomasello, 2005). There are certain functions of a pointing gesture, for example, a protoimperative point, which causes others to do something (e.g. to get others to retrieve an object), or a protodeclarative point, which causes others to know something (e.g. to get others to pay attention to an object) (Tomasello et al., 2007). Regardless of what function dominates a pointing gesture, the basic interpersonal function is – as opposed to other communicative cues mentioned above – to direct another's attention to a referential entity in the world (Kita, 2013). Beginning around their first birthday, infants understand others' pointing gestures as object-directed referential cues (Aureli, Perucchini, & Genco, 2009; Behne et al., 2005; Behne, Liszkowski, Carpenter, & Tomasello, 2012; Bretherton, 1991; Carpenter, Nagell et al., 1998; Desrochers, Morisette, & Ricard, 1995; Leung & Rheingold, 1981; Murphy & Messer, 1977; Tomasello, 1999; Tomasello & Akhtar, 1995; Woodward & Guajardo, 2002). For example, by using a habituation-dishabituation paradigm, infants' understanding of a person's pointing gesture to a referent object was investigated (Woodward & Guajardo, 2002): 9- and 12-month-olds saw how an actor pointed at one of two toys during a habituation phase. Afterwards, participants were presented with test events in which either the referent object changed (pointing at a different object) or the side to which the actor was pointing changed (pointing at the same object). 12-month-olds but not 9-month-olds looked longer at the change of the referent object than at the change of the pointing side, indicating that the older participants encoded the relation between the actor's pointing and the referent. Thus, between the age of 9 and 12 months of age, infants begin to understand a person's pointing gesture as an object-directed action. Moreover, in Behne et al.'s (2005) study, 12-month-olds were presented with a hiding-finding game in which an experimenter pointed at the location of a hidden object. When participants were given the chance to search for the object by choosing one of the two boxes, infants preferred the indicated location over the non-indicated one, emphasizing participants' understanding of the communicative intent of the pointing gesture.

In addition to such a concrete referential cue, there are also more abstract referential cues (e.g. symbols) that can be used to predict or indicate an external entity. One advantage of these abstract referential cues is that they are potentially produced and comprehended bidirectionally

(Tomasello, 1996). That is, the use of the abstract referential cue is usually based on a shared understanding about what it stands for. An example of such an abstract referential cue is a physical marker that can be used as an indicator for an object's location. Previous research shows that 2.5- and 3-year-old children used a wooden block that an experimenter placed on one of three containers to locate a hidden reward in a hiding-finding game (Tomasello, Call, & Gluckman, 1997). Although children performed best when presented with a pointing gesture, they also performed above chance with the physical marker. When presented in an intentional manner, 3-year-olds even use light and sound cues (placed behind the hiding places) as referential cues to find a hidden reward (Moore, Liebal, & Tomasello, 2013). This ability to use such more abstract referential cues extends children's possibilities to communicate with others and, thus, to make use of others' information in social learning situations.

1.1.3 The Selectivity of Infants' Social Learning

Although infants are highly motivated to gather and use others' information, they do not take every piece of information provided by every informant in every context into account in the same way. Rather, as we will demonstrate in the following sections, infants in the first year of life are already selective when looking for and using others' information. This selectivity can be defined as "the predisposition of an organism to process the selectively relevant, as compared to irrelevant, environmental information" (Harter & Aine, 1984, p. 293). In accordance with this definition, infants' selective use of information can be defined as the intended use of information which is most relevant for the current aim, which is to solve a problem in an ambiguous or uncertain situation. Infants' social learning behavior is characterized by selectivity in various ways. Regarding the different aspects of the adapted Organon model, infants can be selective in terms of the context in which a social learning situation takes place. For example, infants at 12 months of age imitated more often in a unique learning context than in a learning context which they had previously experienced (Jones & Herbert, 2008). Moreover, infants can be selective in terms of the features of the medium that is used to transfer information. For example, infants at 14 months of age received more information from an experimenter when her/his information was provided with ostensive cues (i.e. eye contact, eyebrow raising, infant-directed speech, contingent reactivity, motherese, being addressed by one's own name) compared to when it was provided without ostensive cues (Gergely, Egyed, & Király, 2007). Furthermore, infants can be selective in terms of the entity about which information will be provided. For example, infants at 12 and 16 months of age increased their

social referencing behavior when an ambiguous object was presented compared to when a positive or negative object was presented (Kim & Kwak, 2011).

Despite children's strong tendency to over-imitate observed actions, meaning that they copy actions that are irrelevant to achieve an end result (Horner & Whiten, 2005; Keupp, Behne, Zachow, Kasbohm, & Rakoczy, 2015; Lyons, Young, & Keil, 2007; McGuigan, Whiten, Flynn, & Horner, 2007; Nielsen & Tomaselli, 2010), infants already imitate selectively depending on the intentionality and voluntariness of a modeled action. For example, infants in the second year of life differentiate between intentionally and accidentally modeled actions: When participants were shown two-step actions on various apparatuses, wherein the actions were vocally marked as either intentional or accidental ("There!" and "Whoops!" respectively), infants at 14 and 18 months of age imitated almost twice as many intentional as accidental actions (Carpenter, Akhtar, & Tomasello, 1998). Moreover, according to rational imitation studies using the paradigm of non-verbal body-part imitation, infants about one year of age selectively imitated a model's action by taking into account the model's physical constraints. For instance, after participants observed a model illuminating a lamp by touching it with her forehead, those 14-month-olds who had seen the model with her hands free next to the lamp (hands-free condition) were more likely to imitate the observed head action than those who observed the model executing the identical action while her hands were occupied (hands-occupied condition) (head-touch paradigm, Gergely, Bekkering, & Király, 2002). Given the same body part imitation paradigm, similar results were found with 12- but not with 9-month-olds, suggesting that the age of the emergence of rational imitative behavior is around 12 months of age (Zmyj, Daum, & Aschersleben, 2009).

There is even more evidence for infants' selective imitative behavior based on a study applying a rational tool-use paradigm (Buttelmann, Carpenter, Call, & Tomasello, 2008). In this paradigm, when a model freely chooses to use a tool instead of making use of her hands in order to get a reward, 14-month-olds imitated this action by also using the tool. However, infants were more likely to reach for a reward with their hands directly instead of using the tool when the model was previously unable to use her hands due to a transparent barrier as constraint. Similar results were reported for 12-month-olds who were shown a toy dog entering a toy house through its chimney, where the door of the house was either closed or opened (Schwier, van Maanen, Carpenter, & Tomasello, 2006). Those infants who observed the dog choosing to enter the house through the chimney despite the fact that the door was open were more likely to imitate the action of moving the toy dog through the chimney than those who observed the same action with the closed door. These studies indicate that infants at around the first year of life are

quite selective in their social learning behavior in terms of a context of a learning situation, a medium, an entity, as well as the intentionality and voluntariness of a modeled action. Regarding the aspects of the Organon model, one might wonder whether infants are also selective in terms of different informants.

Infants' Selectivity to Informants

Infants grow up and learn in a social environment in which various informants are available to provide infants with information. An infant's environment is often characterized by communicative contacts to a variety of social partners, for example, infants' parents, siblings, grandparents, peers, caregivers in public educational settings, and so on. Given situations in which infants are confronted with more than one informant, the most efficient information gathering occurs when infants are able *to select certain informants who are most relevant to solve a problem*. Whether an informant is considered relevant depends on the recipient's evaluation of the informant as a reliable source of information. Recent research on infants' selective social learning demonstrates that they make certain distinctions between informants based on the previously perceived reliability of informants (Chow, Poulin-Dubois, & Lewis, 2008; Koenig & Echols, 2003; Koenig & Sabbagh, 2013; Poulin-Dubois, Brooker, & Polonia, 2011; Zmyj, Buttelmann, Carpenter, & Daum, 2010; see Harris & Lane, 2013; Lucas & Lewis, 2010 for reviews). For example, 14-month-olds were presented with a reliable looker (i.e. she looked into a container and expressed positive emotions; subsequently infants found an attractive object inside) and an unreliable looker (i.e. she looked into a container and expressed positive emotions; subsequently infants found nothing inside) (Chow et al., 2008). In a following task, participants followed the gaze of the reliable looker to a hidden object but did so less often when presented with an unreliable looker. By adapting the same emotional referencing task, another study tested whether infants at 14 months of age selectively imitated an experimenter who did or did not express past credibility (Poulin-Dubois et al., 2011). The subsequent imitation task of the study consisted of the head-touch paradigm described earlier in this chapter (Gergely et al., 2002). Infants who experienced the reliable experimenter were more likely to imitate the experimenter's modeled action, that is, to illuminate the lamp by using the forehead. These findings indicate that the reliability of a model influences infants' imitative behavior.

There are several other ways to manipulate an informants' reliability. As do preschool children (Birch, Vauthier, & Bloom, 2008; Clement, Koenig, & Harris, 2004; Harris, 2007; Jaswal & Neely, 2006; Koenig, Clement, & Harris, 2004; Koenig & Harris, 2005), infants use an informant's past accuracy when deciding which informant to trust. For instance, 16-month-

olds looked at a model who labeled common objects incorrectly for a longer amount of time than at a model who labeled the same objects correctly, revealing their violated expectation about accurate and, thus, reliable informants (Koenig & Echols, 2003). Moreover, infants also evaluate an informant's reliability based on the previous level of competence (Zmyj et al., 2010). In this study, the 14-month-old participants were presented with a series of videos in which a model acted either competently (e.g., putting a shoe on his foot) or incompetently (e.g., putting a shoe on his hand). Afterwards, comparably to Buttelmann, Zmyj, Daum, and Carpenter (2013), the model demonstrated a novel action (imitation task) and chose one out of two objects (preference task). Although infants' behavior in the preference task was not influenced by the model's previous competence, infants' imitative behavior was: they copied the action more often when the model demonstrated competent actions than when the model demonstrated incompetent actions. Results from studies using the social referencing paradigm provide evidence for infants' evaluation of an informant's reliability based on the previous level of expertise. When facing an ambiguous toy and two experimenters who provide information about the toy but differ in their levels of demonstrated expertise, 12-month-olds looked more at the expert than at the non-expert during the information phase, and also used this information (i.e., played with the toy) more when the toy was presented by the expert rather than the non-expert (Stenberg, 2012, 2013).

Moreover, specific characteristics of a model seem to influence infants' willingness to imitate demonstrated actions. For instance, infants copy peers more often than adults (Ryalls, Gul, & Ryalls, 2000; Zmyj, Daum, Prinz, Nielsen, & Aschersleben, 2012). More specifically, Ryalls et al. (2000) presented 14- to 18-month-olds with a peer or an adult model performing four 3-step actions (e.g., putting a teddy bear to bed). The authors measured participants' imitative behavior immediately after the model phase and again a week later. Infants at both ages preferred to imitate the peer models over the adult models. Similarly, Zmyj et al. (2012) found the same pattern of results for 14-month-olds watching familiar actions done by televised models who differed in age (i.e. peers, older children, or adults). Interestingly, this effect was reversed for novel actions: The likelihood of imitation increased as the model's age increased. In addition to the effects of a model's age on infants' imitative behavior, there is also an effect of a model's group membership. That is, infants imitate actions demonstrated by an in-group member significantly more often than actions demonstrated by an out-group member (Buttelmann et al., 2013). In this study, the 14-month-old participants watched an adult telling a story either in their native language (in-group) or a foreign language (out-group). The model then demonstrated a novel action (imitation task) and chose one out of two objects (preference

task). Although infants were not selective in the preference task, they imitated the in-group model more faithfully than the out-group model. To sum up, beginning at around their first year of life infants imitate selectively by taking an informant's credibility, accuracy, competence, expertise, and characteristics like a model's age and group membership into account. Thus, at this young age infants already select certain informants whom they perceive to be more reliable than other informants and therefore more relevant to the achievement of their current goal.

There are still more aspects of informants that might be relevant for infants when evaluating an informant's reliability. In the following chapters we will introduce the importance of an informant's knowledge state and familiarity as potentially crucial factors for infants' decision to choose the reliable informant – aspects which have not been considered and investigated sufficiently in the research field of infants' selective social learning thus far.

1.2 The Knowledge States of Informants

Infants' selective social learning seems to be especially important in terms of an informant's knowledge state. The more an informant knows about an entity, the more relevant will this informant's provided information be. Since knowledgeable others possess relevant information in a specific situation, the infants' ability to differ between knowledgeable and less knowledgeable informants and, consequently, to select the more knowledgeable informant, enables a better and more efficient process of problem-solving and learning. However, when do children actually know what others know?

1.2.1 Understanding Different States of Knowledge

Infants' understanding of different states of others' knowledge was decidedly investigated within a research field focusing on infants' theory of mind. The term *theory of mind* (Premack & Woodruff, 1978) refers to the "ability to ascribe mental states (e.g. beliefs, intents, desires, pretending, knowledge) to oneself and others as well as to recognize that others have beliefs, desires, and intention that differ from one's own." (Saracho, 2013, p. 949) The most common task to investigate children's theory of mind is the false-belief task that was introduced by Wimmer and Perner (1983). In this task, participants were told a story about a boy (Maxi) who was helping his mother unpack the shopping bag. Maxi asks his mother where to put the chocolate. The mother tells Maxi to put the chocolate into the blue cupboard. Maxi puts the chocolate into the blue cupboard and remembers exactly where he put the chocolate so that he can get some later. Then he leaves to play outside. The mother starts to prepare a cake and takes

the chocolate out of the blue cupboard. However, she does not put it back into the blue but into the green cupboard. When the mother goes to the neighbor's house to get some eggs, Maxi comes back from the playground and wants to get some chocolate. He still remembers where he put the chocolate. After telling this story participants were asked where Maxi will look for the chocolate – a question which addresses the participants' assumptions concerning Maxi's belief. Children began to succeed at this task at around 4 or 5 years of age (Doherty, 2009; Wimmer & Perner, 1983). This onset of a false-belief understanding by using such explicit tasks, which rely on infants' language abilities given the belief question, is supported by a meta-analysis (Wellman, Cross, & Watson, 2001).

However, when studies investigated the false-belief understanding with more implicit tasks, for example, by measuring participants' anticipatory looking behavior, children successfully fulfilled the tasks at around 3 years of age (Clements & Perner, 1994). In this study, participants were presented with a story similar to the one used by Wimmer and Perner (1983), except that two mice and two boxes were part of the story. One mouse (Sam) put a piece of cheese in the one box and went to sleep. The other mouse (Katie) moved the cheese into the other box. When Sam came back to get his cheese, the experimenter added "I wonder where he's going to look?" (Clements & Perner, 1994, p. 383) and 3-year-olds first looked at the empty box, indicating that participants anticipated Sam to look into the box in which he last saw his cheese and thus falsely believed the cheese to be. Another study also measuring anticipatory looking provided evidence for false belief understanding in 2-year-olds (Southgate, Senju, & Csibra, 2007).

Moreover, in an innovative active helping paradigm, Buttelmann, Carpenter, and Tomasello (2009) tested whether 16- and 18-month-olds adjusted their helping behavior to an experimenter's goal. In order to infer his goal, infants had to take into account the experimenter's beliefs in their inferential process. According to the procedure of the study, the experimenter wanted to find an object in one of two boxes while having either a true belief or a false belief about the object's location. The different belief conditions were manipulated in accordance with the procedure of the previously reported false-belief studies. That is, the experimenter observed how the assistant moved the object from one to the other box in the true-belief condition, and he went outside the room and did not observe how the assistant moved the object from one to the other box in the false-belief condition. Subsequently, the experimenter tried but failed to open the box where he last saw the object and therefore believed the object to be. Participants were then asked to help the experimenter. Infants at 18 months of age preferably tried to open the target box (i.e., containing the object) in the false-belief condition and they opened the empty box in the true-belief condition. There were no significant effects

for the 16-month-olds although their responses were similar. Thus, the older participants successfully considered the experimenter's belief in order to infer his goal. A similar statement could be made by Buttelmann, Suhrke, and Buttelmann (2015), using an unexpected-identity task. This task derived from the appearance-reality paradigm (involving deceptive objects that appear to be something other than they actually are, for example, a sponge that looks like a rock). According to the experimental condition, either an assistant demonstrated an object's real identity to the experimenter (i.e., a sponge, true belief) or the experimenter just looked at it without the assistant's demonstration of the object's real identity and therefore thought that the object was what it appeared to be (i.e., a rock, false belief). The experimenter then requested the 18-month-old participants for help by reaching for the deceptive object. Subsequently, the assistant revealed two objects wherein one resembled the apparent reality and the other one resembled the real identity of the deceptive object. Infants selectively helped the experimenter achieve her goal given her belief about the identity of the deceptive object that is, by handing over the real identity object (i.e. the sponge) more often in the true belief rather than the false belief condition.

Furthermore, another study tested the false-belief understanding in 15-month-old infants by using a violation-of-expectation Sparadigm (Onishi & Baillargeon, 2005). In this paradigm, infants' looking behavior was measured in order to infer their expectations about a situation, wherein a longer looking time indicates surprise about an event that was unexpected to the infants. The setup consisted of an experimenter sitting behind a table facing two boxes. Similar to the idea of the studies mentioned above, an assistant moved an object from one to the other, without the experimenter's visual access (a screen was put between her and the boxes) and, thus, without her knowledge about the current location of the object. The action of interest in this study took place in the moment when the experimenter reached for the object in one of the boxes. Participants were shown two outcomes that differed in terms of their congruence given the experimenter's beliefs. That is, the experimenter reached either to the box in which she last saw the object and, therefore, thought the object to be (congruent outcome), or she reached to the other box that actually contained the object (incongruent outcome). Infants looked longer in the incongruent as opposed to the congruent outcome. Thus, infants were surprised when the experimenter reach to the object-containing box and apparently expected her to reach into the empty box, suggesting infants' understanding of her belief.

Moreover, a study by Kovács, Téglás, and Endress (2010) provided evidence for false-belief understanding even in 7-month-old infants, again by using the violation-of-expectation paradigm. In this task, participants were shown a video displaying a ball behind a barrier

wherein the ball either remained (or left and returned) behind the barrier and thus could be expected to be present behind the barrier in the final still picture, or the ball left the scene and ultimately was not to be expected behind the barrier. These actions were observed by an agent who was present in the video demonstration. At the end, participants were presented with an outcome picture with the ball being present. According to various conditions, the outcome was either congruent or incongruent to the participants' and the agent's belief about the presence of the ball. Infants' looking behavior was not only influenced by their own beliefs but also by the agent's beliefs, that is, they consistently looked longer at the incongruent rather than the congruent outcome. This evidence of participants' violated expectations based on the mere presence of an agent indicates that 7-month-old infants automatically encode others' beliefs.

As a result, depending on the task that was used, 7- and 15-month-olds show surprise at an action when this action was inconsistent with others' beliefs; 18-month-olds take into account others' beliefs when inferring their goal and when helping them to achieve this goal; 2-year-olds anticipate an agent's actions based on others' false belief; and children around 4 years of age succeed in explicit false belief tasks. The more that the tasks were adapted to participants' abilities to perform the task successfully, the more results underlined that even young infants take other people's different knowledge states in their social environment into account, ultimately emphasizing infants' "special motivation to share psychological states with other persons" (Tomasello et al., 2005, p. 7).

1.2.2 Infants' Selectivity due to Informants' Knowledge States Based on their Local Expertise

As mentioned above, to understand and take an informant's knowledge state into account enables a better and more efficient process of problem-solving and learning, since knowledgeable others possess relevant information in a concrete situation. However, whether the social learning behavior of infants at around their first year of life is indeed affected by others' knowledge states is still an open question in developmental psychology research. Some studies claim that infants learn about an object (Stenberg, 2009, 2012) or a modeled action (Seehagen & Herbert, 2012) from those informants more who are associated with the location in which the experiment takes place. For instance, an experimenter can be perceived as the expert in the laboratory, which means that s/he is "knowledgeable about the laboratory situation" (Stenberg, 2012, p. 667) and, therefore, might be considered a reliable source of information in this location. Accordingly, parents might be perceived as the experts in the infants' homes. Recent studies suggest that infants' social learning might indeed be driven by

such an evaluation, suggesting infants' "rudimentary understanding that knowledge can be situation specific" (Stenberg, 2012, p. 643; Stenberg, 2009; Stenberg & Hagekull, 2007). In these studies, the experimenter expressed her local expertise by showing the parents and their infants how to get to the laboratory, that is, she opened the doors, showed the family where to sit, offered and provided the beverages, and so on. In the subsequent experiment, a familiar person (i.e., the infants' parent) and an unfamiliar person (i.e., the experimenter) presented an ambiguous toy to infants and provided emotional information about this toy while infants' looking behavior was measured. Afterwards, the toy was given to infants, and the authors measured how long the infants played with the toy. Results revealed that infants looked at the unfamiliar rather than the familiar person for a longer amount of time, and they played with the toy more when it had been presented by the unfamiliar person than when it had been presented by the familiar person. The authors concluded that infants predominantly learned from experts, while expertise depended on infants' association of a person with a certain learning context (*local expertise*). This would suggest that infants are able to "determine from another person's behavior if a person is knowledgeable or not about a particular situation" (Stenberg, 2012, p. 643). However, because such questions have only been tested in the laboratory, they offer only limited support for the idea that infants' selective behavior toward unfamiliar agents is explained by associations they form between certain locations and individuals. Since Stenberg and colleagues' experiments took place solely in the laboratory, the expert was always the experimenter but never the infants' parents, leaving it unclear whether the local expertise truly drives infants' social learning. Stenberg (2009) pointed out the necessity of varying the location of the study in addition to varying the presenter of the toy in order to substantiate conclusions about the influences that both the informants' familiarity and the learning context have on infants' reception and use of information. As a first attempt to investigate this, Seehagen and Herbert (2012) tested 6-month-olds' imitation by varying both the informants' familiarity and the location of the experiment. Participants either observed the experimenter or their mother modeling an action on a decorated wooden box six times in total. The action demonstration was to push a button on the box, which elicited a croaking sound. In the laboratory location, 5 out of 14 infants copied the action modeled by the experimenter, whereas only 3 out of 14 infants copied the action modeled by the parent. In the home location, these numbers were reversed. Based on these findings the authors concluded that infants' imitative behavior was sensitive to both types of cues, which would be supporting evidence for the local-expertise hypothesis. However, given the action demonstration, it is not possible to sufficiently interpret infants' copying responses as imitative behavior since it could have been merely emulation. Moreover,

the authors did not compare both conditions directly, as should be done in a 2 x 2 design. Since such comparison results in a lack of differences between locations, we cannot draw valid conclusions about the influence of informants' familiarity and the learning context on infants' imitative learning from this study. Thus, further evidence is required outside the laboratory location, not only to investigate whether the local-expertise hypothesis is a valid explanation for infants' preference for the experimenter over the parent in prior studies, but also to generate more knowledge about whom infants select as a reliable source of information in certain locations.

1.2.3 Infants' Selectivity due to Informants' Knowledge States Based on their Visual Perspective

A person's perceptual access is an important prerequisite in order to possess information about an entity. A relevant perceptual access concerns the visual perspective to a certain object, subject or situation. This visual perspective determines whether one gathers information or not and, thus, whether one is knowledgeable about an entity or not. Therefore, to select the most reliable source of information, it is important to take an informant's visual perspective into account. With respect to Piaget, children are characterized by egocentrism and, therefore, have difficulties taking others' perspectives into account until the age of 6 or 7 years. Piaget and Inhelder (1977) demonstrated this, for instance, when they presented 4-year-olds with a physical model that consisted of three mountains of different sizes. Participants were asked to choose which of several pictures depicted what a doll sitting in a seat across the table would see. In order to do so, children had to take the doll's view into account and to inhibit their own perspective. Most of the 4-year-olds were not successful. Even most of the 6-year-old children selected the picture of the scene based on their own perspective.

However, this study addressed a more sophisticated level of perspective taking. According to Flavell (1974, 1977, 1992) there are two different levels of perspective taking: Level 1 refers to children's understanding that the content of what a child sees may differ from the content of what another person sees in the same situation (i.e. what we see is different), whereas Level 2 focuses on children's understanding that the child and another person may see the same thing simultaneously from different perspectives (i.e. how we see the same thing is different). Given this distinction, Piaget and Inhelder (1977) had investigated children's ability of Level 2 of perspective taking. By using similar tasks but focusing on Level 1 of perspective taking, children are successful at around 2 to 3 years of age (Flavell, Everett, Croft, & Flavell, 1981; Masangkay et al., 1974).

Moreover, there is empirical evidence suggesting that even infants are able to take others' perspectives into account at Level 1. In a study conducted by Brooks and Meltzoff (2002), 12-, 14-, and 18-month-olds were presented with an adult looking at one (target object) of two objects, either with an unobstructed view (open eyes in experiment 1; headband in experiment 2) or obstructed view (closed eyes in experiment 1; blindfold in experiment 2). In the first experiment, participants at all ages looked at the target object more often in the open-eye condition as opposed to the closed-eye condition. In the second experiment, 14- and 18-month-olds looked more consistently at the adult's target object in the headband condition rather than in the blindfold condition. Both experiments indicate that infants at this age take others' visual perspective into account and relate others' looking at external targets. Moreover, 12.5-month-olds also consider what objects others can see when they interpret their actions. Luo and Baillargeon (2007) presented infants with an experimenter who always reached for object A while object B was either visible to the experimenter given a transparent screen, hidden from the experimenter (but visible to infants) by an opaque screen, or placed by the experimenter herself behind an opaque screen (meaning that she knew of the presence of object B but could not see it). After the experimenter reached for and grasped object A she paused in this position and participants' looking time at the paused event was measured. The looking time data indicated that infants interpreted the experimenters repeated actions to object A as a preference for object A over object B only when the experimenter could see object B or was aware of its presence. Thus, participants took the visual perspective and with it the experimenter's representation of the physical setting into account.

Using a violation-of-expectation paradigm, Poulin-Dubois, Polonia, and Yott (2013) presented 14- and 18-month-old participants with two transparent boxes. In a first experiment, an experimenter put an object into one of the two boxes and, subsequently, searched for the object either in the target location, which contained the object, or in the empty location. Infants looked longer in the empty-location event than in the target-location event. In a second experiment, the procedure of experiment 1 was repeated, however, the experimenter now wore a blindfold. There was no differential looking between both conditions in experiment 2. This reveals that infants' surprise about the experimenter's action in experiment 1 was indeed based on infants' violated expectation about the experimenter's and not the infants' visual perspective. Furthermore, Sodian, Thoermer, and Metz (2007) investigated the ability of visual perspective taking in 14-month-olds. In this study, participants saw an experimenter repeatedly reaching for object A (old target object) and, afterwards, attempted to grasp object B (new target object) while object A was either still visible to the experimenter or not (though it was visible to infants

at all times). The measurement of infants' looking time showed that infants looked longer at the action in the condition in which the old target object was still visible to the experimenter as opposed to the condition in which it was not. This evidence of infants' violated expectations refers to 14-month-old's ability to recognize others' visual perspective.

Moreover, 14- to 18-month-old infants know what others experience in joint engagement situations (Moll, Carpenter, & Tomasello, 2007; Moll & Tomasello, 2007). For example, based on a similar procedure of a former study (Tomasello & Haberl, 2003), 14-month-olds played with two objects while an experimenter experienced each of the objects – without manipulating them – in joint engagement episodes with the infant (Moll et al., 2007). Subsequently, the infant played with a third object with an assistant while the experimenter left the room. After the experimenter returned and excitedly requested an object while facing all three of them, participants gave the experimenter the object she had not experienced before. Thus, infants showed that they knew which ones the experimenter was familiar with by giving her the object that was novel to her. In line with this finding, infants at 12 months of age point appropriately for knowledgeable versus ignorant informants (Liszkowski, Carpenter, & Tomasello, 2008). According to the conditions of the study, an experimenter either had or had not seen an object fall down just beforehand. However, infants observed the object falling down and pointed more often to the object's current location in the condition in which the experimenter did not know the object's location and thus needed information as opposed to the condition in which the experimenter knew the object's new location.

As a result, there is evidence that infants within their second year of life already take others' visual perspective into account at Level 1 of perspective taking. However, most of those studies based their inferences only on infants' looking behavior, and none of the studies investigated the behavioral consequences of others' visual perspective on infants' use of others' information. Therefore, it is still an open question whether infants use others' knowledge based on others' visual perspective for their own selective decisions when learning from others as reliable sources of information.

1.3 The Familiarity of Informants

That the familiarity of informants might be of considerable importance for infants' social learning becomes more obvious with respect to infants' developmental origins. After the fertilization of the egg cell and, thus, the beginning of their existence, human beings grow up and build a relationship with their mother. In this continuous relationship, infants already experience their mother on various levels in their mothers' womb: infants hear their mother's voice (Fifer & Moon, 1995), subsist through and taste their mother's amniotic fluid (Gandelman, 1992), make their first moves in their mother's womb by boxing and kicking against it (Robertson, 1990), and so on (see Siegler et al., 2011, for an overview of the fetus' experiences). Moreover, from birth on, infants experience additional recurring relationships, first of all, with their mother and father. Depending on the situation, they also get to know their brothers and sisters, their grandparents, and their parents' friends. They recognize, touch and communicate with those people in their commonplace social environment. These relationships – especially those with their parents – crucially contribute to the development and perception of a feeling of familiarity. Thus, familiarity between the infant and other human beings is based on their shared experiences. These shared experiences in infants' everyday life across a longer period of time, in turn, form the basis of talking about and investigating the effects of familiar informants on infants' social learning behavior in the present dissertation.

1.3.1 The Importance of Familiarity

The importance of familiar informants for infants' development and social learning can be much better understood with respect to attachment theory. The construct of attachment is defined as "a lasting psychological connectedness between human beings" (Bowlby, 1969, p. 194). Bowlby's (1969) attachment theory postulates that children are biologically predisposed to form attachments with others to increase chances of their own survival. According to this theory, infants are motivated to become competent and, therefore, they use their primary caregiver as a secure base (Waters & Cummings, 2000). This secure base, in turn, refers to the idea that the primary caregivers – mainly infants' parents – provide their offspring with a feeling of security from which the offspring is able to explore its environment. Following Bowlby, the attachment process develops comparably to imprinting, since the process is based on the interaction between infants' learning biases (e.g., infants' strong tendency to look at faces, Thomas & Jones-Molfese, 1977) and their experience with their parents. In his theory, Bowlby claimed that attachment develops in four phases: pre-attachment (birth to 6 weeks of

age), attachment-in-the-making (six weeks up to six to eight months of age), clear-cut-attachment (between six to eight months and 18 months of age), and reciprocal relationships (from 18 months or two years of age onwards) (Bowlby, 1969; see also Siegler et al., 2011). In the pre-attachment phase, infants produce signals (e.g. crying) to provoke the presence of parents and to be satisfied by the interactions that follow. In the attachment-in-the-making phase, infants preferably react to familiar people. In the presence of those people, infants typically produce more smiles, laughs, babbling, and are more easily soothed by them. In this phase, infants form expectations about the parents' reactions to the own needs, and they do or do not develop a feeling of trust for their parents. In the clear-cut-attachment phase, infants actively search for contact with their parents. An infant happily greets its mothers when she appears, and, accordingly, they show anxiety or distress when she disappears. For most children, the mother now functions as a secure base, facilitating infants' exploration and control of their environment. In the reciprocal relationship phase, the relationship between children and their parents becomes mutual, based on children's increased cognitive and language skills. In other words, children play a more and more active role in building a functioning partnership with their parents.

1.3.2 The Influence of Familiar versus Unfamiliar Informants

According to the previous section, parents seem to be important in their function as a secure base for infants' exploratory behavior and their learning about the world. In addition to the function as a secure base from which infants explore their environment, parents also function as a source of information for their offspring. However, do infants actually prefer to use familiar informants as a reliable reference or source of information compared to unfamiliar informants? In the following section, we focus on empirical evidence concerning the influence of the informants' familiarity on infants' reception and use of information.

Regarding the habituation phenomenon – "a behavioral response decrement that results from repeated stimulation" (Rankin et al., 2009, p. 136) – one could assume that something that is familiar (e.g., familiar informants) elicit less attention than novel stimuli (e.g., unfamiliar informants) (see Thompson & Spencer, 1966, for the original study introducing the habituation-dishabituation paradigm). However, a look at the following studies reveals that this assumption might be too simple, especially when it comes to the (un)familiarity of social beings. In a study with 3.5- and 6.5-month-old participants, infants' visual recognition memory of shapes as stimuli was investigated with a paired comparison procedure (Rose, Gottfried, Melloy-Carminar, & Bridger, 1982). Regardless of age, participants preferred to look at familiar stimuli

as they began to process a stimulus, however, their preference shifted to the novel stimulus as soon as the processing became more advanced. Accordingly, 4.5-month-olds were shown a series of brief choice trials between a stimulus that was different in every trial (novel stimulus) and a stimulus that remained the same (familiar stimulus) (Roder, Bushneil, & Sasseville, 2000). When using novel and familiar stimuli that contained objects or faces, infants showed selective attention to the familiar stimulus prior to preferring the novel stimulus. These results match those by Rose et al. (1982) and document a spontaneous preference for familiarity early in processing stimuli that is followed by a preference for novel stimuli at a later sequence in the cognitive processing. Moreover, 9- to 24-month-olds were presented with pictures of parents and strangers and measured infants' attention and facial reactions (Brooks-Gunn & Lewis, 1981). Participants smiled more often and looked longer at pictures of their parents than at those of strangers. Additionally, younger participants were more likely to smile at familiar than at unfamiliar faces than older participants were. As an interim result, infants from 3.5 to 24 months of age seem to spontaneously prefer looking at familiar rather than unfamiliar stimuli in non-ambiguous situations without social interactions. Thus, a next step will be to focus on studies that investigated infants' preference for familiar versus unfamiliar people in social interactions.

Newborns prefer to look at their mothers' face more than at the face of a stranger (Ainsworth, 1964; Bartrip, Morton, & Schonen, 2001; Bushneil, Sai, & Mullin, 1989; Bushnell, 1998; Field, Cohen, Garcia, & Greenberg, 1984; Pascalis, Schonen, Morton, Deruelle, & Fabre-Grenet, 1995). However, there is no difference in the facial imitation of familiar versus unfamiliar people in 6-week to 3-month-old infants. At that age, infants imitated both the facial expressions of a stranger and their mother (Meltzoff & Moore, 1992). Moreover, another study investigated 3.5-month-olds' sensitivity to the dynamic facial emotions (i.e., happy, sad, angry) displayed by familiar and unfamiliar others (Montague & Walker-Andrews, 2002). Infants differed in their looking behavior between the different kinds of emotions when the mother displayed the emotions, but there were no differences when the father or an unfamiliar adult expressed the emotions. Thus, an informant's familiarity may facilitate infants' developing understanding of others' emotions. Similarly, it was investigated whether 3.5-month-olds' ability to recognize others' emotional expressions (i.e., happy and sad) is affected by person familiarity (Kahana-Kalman & Walker-Andrews, 2001). In this study, the informants' facial expressions were videotaped and presented to infants as short movie clips accompanied by a single vocal expression which was congruent with one of the two facial expressions. The authors measured infants' looking preferences and facial expressions. Participants looked significantly longer at the congruent than at the incongruent expressions when the mother displayed the emotions.

However, infants did not differ when presented with emotional expressions of an unfamiliar female informant. Moreover, when infants watched the films of their mother, they were more interactive and expressed more positive and less negative affect. In addition, infants expressed more often full and bright smiles in the happy emotion condition, especially if displayed by their mother. Accordingly, the mean duration of negative affect was longer for infants who observed the unfamiliar informant compared to the observation of their mother. This might refer to infants' reaction that Bowlby called "the fear of strangers", although this aversion usually does not start until around 8 months of age (Bowlby, 1969, p. 323). This stranger aversion increases at 9 or 10 months of age (Ainsworth, 1967), while its peak in intensity is supposed to be in the second half of the first year (Tennes & Lampl, 1964) or within the second year (Morgan & Ricciuti, 1969). Thus, in combination with the preferences for looking at and reacting to the emotional expressions of familiar rather than unfamiliar informants in the reported studies, this stranger aversion might affect infants' choice when they have to decide to pay attention to and use information from familiar versus unfamiliar informants.

However, is there already a clear preference for familiar rather than unfamiliar informants? There is not. In a study including 4- to 15-year-old children the impact of a person's familiarity on emotion understanding (i.e., happy, sad, anger, fear, disgust) was investigated (Herba et al., 2008). Whereas the informants' familiarity did not affect participants' recognition of sad emotions, it did in terms of anger, fear, and disgust: Children were less accurate at recognizing these emotional expressions in familiar as opposed to unfamiliar adults. The authors conclude that a persons' familiarity might distract children from an appropriate recognition of others' emotions, for example, when the familiar adult's emotional expressions displayed in the experiment appear to be less natural than those usually experienced by their children. This result for older children contrasts with the studies that emphasized young infants' preference for familiar informants and stimuli. That means that there must be a developmental change towards the preference for unfamiliar informants at some point. The turning point is likely present much earlier than the age of participants in the study by Herba et al. (2008) would suggest. If we look at the results of studies using the social referencing paradigm, which investigates infants' reaction to others' emotional expressions in ambiguous situations, we discover an interesting pattern. There, 12-month-olds prefer to look at an unfamiliar rather than a familiar informant when infants are involved in a situation with an ambiguous object (Stenberg, 2003, 2009; Stenberg & Hagekull, 2007; Walden & Kim, 2005). For example, a familiar person (i.e., the infants' parent) and an unfamiliar person (i.e., the experimenter) presented an ambiguous toy to infants and provided emotional information about this toy (Stenberg, 2009; Stenberg

& Hagekull, 2007; see section 1.1.2 and 1.2.2). When participants were given the toy, the authors measured the time infants spent looking at the informants and playing with the toy. They found that infants looked longer at the unfamiliar person than at the familiar one, and played more with the toy when it had been presented by the unfamiliar person. In contrast, another study presented 14-month-olds with an uncertainty-provoking object (a toy spider) and, between subjects, different emotional information provided by a familiar or unfamiliar informant (i.e. mother-happy, mother-fearful, stranger-happy, stranger-fearful) (Zarbatany & Lamb, 1985). Participants only responded differently between the two emotions when the emotions were displayed by their mother. That is, the infants' approach behavior to the toy was influenced by their mothers' emotional expressions but not by the expressions of the stranger. This finding of preferring a familiar informant in ambiguous situations was also demonstrated by older children. More specifically, a study presented 50- and 61-month-old children with conflicting claims made by their mother and a stranger, for example, about the name or function of a novel object and the name of ambiguous animals (i.e. pictures of 50%-50% hybrids) (Corriveau & Harris, 2009). Participants generally preferred to accept their mother's claim over those of the stranger. Only when the pictures of animals were less ambiguous (i.e. pictures of 75%-25% hybrids), for example, 75% bird and 25% fish, and the stranger claimed the animal to be a bird whereas the mother claimed it to be a fish, did children trust the stranger over their mother. That means, the more ambiguous the visual cues were, the more participants preferred to use their mother's information over that of a stranger.

Thus, given the results of studies that involved ambiguous situations or objects – which increase infants' motivation for social learning (Kim & Kwak, 2011) – the empirical evidence concerning children's and especially infants' preferences for familiar versus unfamiliar informants is contradictory. This contradiction of results indicates an interesting change of infants' preference for familiar versus unfamiliar informants. However, many studies focused on infants within their first year of life and, by now, no consistent findings exist concerning the impact of an informant's familiarity in infants within their second year. In addition, empirical evidence is missing in order to conclusively interpret the present data by referring to the cognitive mechanisms underlying infants' preferences. Given the general relevance of familiar and unfamiliar persons for infants' social learning, and – with respect to the transition from home to unfamiliar environments and unfamiliar caregivers in Westernized cultures – the remarkable change in infants' social environment within their second year of life, it is important to generate more knowledge about how infants take an informant's familiarity into account when choosing a reliable source of information.

1.4 The Parent-Infant Interaction

Thus far we have focused on the selective preference for familiar versus unfamiliar informants for infants *as a group*. However, it is likely that there are also inter-individual differences that determine infants' selectivity. One factor that might account for such differences is the quality of interaction between parents and their infants. According to theories about social development and social learning, infants develop and learn through social interactions (Bandura, 1971; Bandura & Walters, 1963; Fthenakis & Oberhuemer, 2004; Gaile, 1993; Vygotsky, 1978; Vygotsky et al., 1962). In most cultures, infants spend their first year of life at home in numerous interactions with their parents, providing a secure base for infants' learning and development (Bowlby, 1969). As reported in the description of Bowlby's attachment theory in the previous chapter, the development of attachment depends on infants' experiences with their parents. These experiences, in turn, are made through social interactions with their parents. A further look at the development of attachment demonstrates that parents' reactions to infants' behavior, in particular, play an important role for infants' attachment to their parents (see Wolff & Ijzendoorn, 1997, for a meta-analysis) and, with it, their trust in their parents as reliable supporters for the infants' development. As mentioned above (see section 1.3.1), in the pre-attachment phase, infants provoke social interactions with their parents by sending communicative signals, such as crying. Similarly, in the clear-cut-attachment phase, infants actively initiate contact with their parents. In the attachment-in-the-making phase, infants form expectations about how the parents react to the own needs. Based on these expectations, infants do or do not develop a feeling of trust in their parents. This, in turn, refers to the essential role of the parents' behavior during interaction with their offspring.

1.4.1 The Importance of Parental Behavior in Parent-Infant Interaction

Infants persistently behave or communicate in a certain way, for example, expressing their current state of well-being to signal satisfaction (e.g., by smiling, babbling, exploring, or sleeping) or distress (e.g., by crying due to hunger, thirst, tiredness, illness, or fear). Previous research demonstrated that parental behavior in the parent-infant interaction influences their offspring's development, in particular in the ways in which parents take into account and respond to these and other types of infants' signals and behaviors. One of the most important factors here is a parent's sensitivity, that is, the "ability to perceive and to interpret accurately the signals and communications implicit in her infant's behavior, and given this understanding, to respond to them appropriately and promptly" (Ainsworth, Bell, & Stayton, 1974, p. 127).

Another factor, which is also used to investigate parental behavior in the parent-infant interaction is the construct of responsiveness. Responsiveness is typically measured by focusing only on the promptness or frequency of parents' reactions to infants' signals, irrespective of the reactions' appropriateness (Wolff & Ijzendoorn, 1997). However, as in the subsequently presented studies, "the term responsiveness is sometimes also used to indicate sensitivity" (Wolff & Ijzendoorn, 1997, p. 573). Thus, although using different terms, these studies actually all refer to the same construct, that is, a parent's sensitivity. A parent's sensitivity is not only important for infants' attachment quality (see Wolff & Ijzendoorn, 1997, for a meta-analysis), but also positively affects infants' and children's social and cognitive development (Aschersleben, 2008; Beckwith, Cohen, & Hamilton, 1999; Bornstein & Tamis-LeMonda, 1997; Bradley, 1989; Coates & Lewis, 1984; Crockenberg, 1983; Fish & Crockenberg, 1981; Goldberg, Lojkasek, Gartner, & Corter, 1989; Hardy-Brown, Plomin, & DeFries, 1981; Lewis, 1993; Olson, Bates, & Bayles, 1984; Parpal & Maccoby, 1985; Schneider, 2010). For example, a mother's responsiveness to infants at three to five months of age influences children's general cognitive competence at four years of age, especially in terms of children's perceptual performance (Lewis, 1993). Further, maternal responsiveness in the first year of life has been associated with infants' social and cognitive competence at the age of 4 (Goldberg et al., 1989). More specifically, the more responsively that mothers reacted to their infants, the more those children expressed response flexibility and the less they suggested aggressive strategies to hypothetical social problems at preschool age.

Moreover, parental sensitivity supports infant's behavior in social interactions (Hobson, Patrick, Crandell, Garcia Perez, & Lee, 2004; Kivijärvi et al., 2001; Landry, Garner, Swank, & Baldwin, 1996; Landry, Smith, Miller-Loncar, & Swank, 1998). For instance, maternal sensitivity and infants' behavior in early interactions was observed in free-play situations of 57 mother-infant dyads with infants at 3 months and 12 months of age (Kivijärvi et al., 2001). In this study, maternal sensitivity was related to infants' positive aspects of mood, social and play behavior, as well as visual contact to their mothers at both ages. A further study examined whether maternal sensitivity is related to 1-year-old infants' joint engagement in triadic relations, which the authors defined as "to orientate to an adult's engagement with objects and events in the world" (Hobson et al., 2004, p. 470). The results revealed that maternal sensitivity positively correlated with infants' triadic engagement with a stranger, however, there was no correlation in a non-social task. Thus, this specific pattern of results indicates that maternal sensitivity is related to the motivation of even 1-year-olds to engage with others about things in the world. This triadic engagement of infants is based on infants' focus of attention and interest,

which itself reflects a behavioral expression of infants the parents can react to in a more or less sensitive way.

The measurement of sensitivity, however, often focuses on parents' reactions to infants' basic needs, that is, the degree of satisfying infants' physical and emotional needs (Meins, Fernyhough, Fradley, & Tuckey, 2001). Most studies that investigated the construct of sensitivity did not take into account that "when the child is physically and emotionally satisfied, the most appropriate kind of sensitivity would appear to be the mothers' reading of her infant's focus of attention, readiness to play, and enjoyment of particular kinds of activity" (Meins et al., 2001, p. 638). This statement suggests a change of relevance in infants' current needs. That is, the more that infants' basic needs are satisfied, the more they are able to express their motivation and intention to actively acquire and explore the surrounding culture and environment. This refers to the hierarchy of needs (Maslow, 1970), a model that assumes humans to be motivated to satisfy more basic needs (e.g., physiological requirements, safety, love, and esteem) before they satisfy more growth needs (e.g., self-actualization, that is, to pursue inner talent, creativity, or fulfillment). Although the strict hierarchy of needs does not correspond to the complex motivational system of humans (for critics of this model, see Conrad, 1983; Wahba & Bridwell, 1976), the principal distinction between more basic needs to ensure survival and more growth needs to enable development in terms of self-actualization helps to clarify the change of relevance in infants' current needs. This change of relevance is likely strengthened by infants' developing abilities. That is, the more matured abilities they possess as they grow up (e.g., increase of cognitive and motor abilities), the more they are able to actively acquire and explore the world around them.

A core feature of the definition of sensitivity mentioned above is the *appropriateness* of a parent's reaction to the infants' behavior. To be sensitive by reacting appropriately to the infants' signals thus means to take the infants' interests and focus of attention into account when interacting with them. Thus, researchers suggest "to distinguish between a mother's general sensitivity to her child's physical and emotional needs (…) and a more specific sensitivity to the child's mental states and ongoing activity" (Meins et al., 2001, p. 639; Fonagy, Steele, Steele, Higgitt, & Target, 1994; Meins, 1997). This emphasizes Ainsworth's claim still more that a sensitive parent is one who is "capable of perceiving things from [the child's] point of view" (Ainsworth, Bell, & Stayton, 1971, p. 43). This capability includes the parent's readiness to change her/his own focus of attention in response to infants' current level of engagement (Meins et al., 2001). Against this background, Meins et al. (2003) developed a concept that is called "mind-mindedness", which refers to "the proclivity to treat one's infant as an individual

with a mind, rather than merely an entity with needs that must be satisfied" (Meins et al., 2003, p. 1194). The concept reflects a parent's tendency to treat infants as intentional agents. Thus, children's theory-of-mind development was not surprisingly found to be predicted on the mind-mindedness of their parents (Meins et al., 2002). Mind-mindedness is measured by coding a parent's mind-related comments in a free-play situation with their offspring. The comments include, for example, the comprehension of infant's mental states, such as knowledge, thoughts, desires, and interests (e.g. "You *want* the frog"; "Do you *know* what color this is?") (Meins et al., 2003). The concept of mind-mindedness reflects an important theoretical basis, though it mainly focuses on parents' verbal comments irrespective of their non-verbal engagement towards infants' focus of attention. Thus, in the following section we will present another measurement which includes both the parents' verbal and non-verbal engagement.

To sum up, the construct of sensitivity is often measured in terms of the parents' reactions to infants' basic needs (i.e. physical and emotional needs). However, when infants' basic needs are satisfied and when they develop more mature cognitive and motor abilities to actively acquire knowledge and explore the world around them, focusing on the parents' sensitivity to infants' basic needs no longer sufficiently investigates whether the parents' reactions to infants' behavior are appropriate. Thus, especially for infants beyond the first year of life, it is important to investigate a specific sensitivity to infants as intentional agents with their own focus of attention when exploring the world around them. Moreover, in order to comprehensively investigate this specific sensitivity it is important to take both the parents' verbal and non-verbal sensitive responses into account. In the following section we will introduce two variables which address the requirement of measuring parents' sensitivity to the behavior of infants in the second year of life: Warm Sensitivity and Maintaining Attention.

1.4.2 Warm Sensitivity and Maintaining Attention

Warm Sensitivity measures "the degree of sensitivity the mother display[s] to the child's cues, including the promptness and appropriateness of reaction, acceptance of the infants' interests, amount of physical affection, positive affect, and tone of voice" (Bartling, Kopp, & Lindenberger, 2010, p. 6). The variable is measured during an infant-parent free-play situation in which infants' survival needs are typically currently satisfied. Thus, in the toy-centered free-play situation, the parents' sensitive reactions are targeted at the infants' ongoing play activities and focus of attention. Therefore, Warm Sensitivity measures how warmly, positively, supportively, and contingently the parents respond to the signals and interests that the infants express in their play behavior. Similar to the effects of maternal sensitivity reported above,

Warm Sensitivity was found to positively influence children's social and cognitive development (Belsky, Fish, & Isabella, 1991; Goldberg et al., 1989; Landry et al., 1998). For instance, in a study, this type of mother's interactive behavior was observed and the 6- to 40-month-old infants' social skills during daily activities and toy play in their homes was measured (Landry et al., 1998). The analyses revealed that maternal Warm Sensitivity supported children's development of responsiveness to the mother's signals.

Furthermore, to investigate the active engagement of parents' sensitivity to infants' current activities in respect of infants' focus of attention, we refer to a variable that is called Maintaining Attention. Maintaining Attention reflects the parent's verbal and non-verbal engagement during the common play based on the infant's focus of attention (Bartling, Kopp, & Lindenberger, 2010; Landry et al., 1998). When maintaining infants' attention the parents stay involved in the current activities of infants and follow, enrich, or elaborate infants' ideas in common play. As investigated in a study, mothers' Maintaining Attention in parent-infant interaction was related to a higher complexity of exploratory play in the 6-month-old participants (Landry et al., 1996). Moreover, Maintaining Attention seems to promote infants' attention skills since parents' high levels of Maintaining Attention were positively correlated with better focused attention in 18-month-old infants (Bono & Stifter, 2003). In this study, the researchers observed mothers' behavior during the free play with their infants and measured infants' focused attention abilities by using the Bayley Scale (Bayley, 1993). Moreover, as for Warm Sensitivity, the study by Landry et al. (1998) provides evidence for the supportive effect of Maintaining Attention on infants' responsiveness to maternal requests as well as infants' initiations of social interactions. Thus, infant's attention and responsive reactions within social interactions are supported by the amount of time parents maintain the infant's attention during common play. For a summary of the measured components of the variables Warm Sensitivity and Maintaining Attention see Table 1.

Table 1. *Maintaining Attention and Warm Sensitivity. The table contains the measured components of the variables Warm Sensitivity and Maintaining Attention.*

Variables	Measured Components
Warm Sensitivity	Promptness of reaction (contingency); appropriateness of reaction as acceptance of the infants' interests (support); amount of physical affection, positive affect, and tone of voice
Maintaining Attention	Parent's verbal and non-verbal engagement during the common play based on the infant's focus of attention

Both Warm Sensitivity and Maintaining Attention are parental behaviors of "special importance" (Landry et al., 1998, p. 106; see also Maternal Affect Attunement Scale for further descriptions to both variables, Bartling et al., 2010; Landry et al., 1998). The two measurements pertain to the core concept of sensitivity in its original sense, that is, to respect – in its original meaning (lat. *respecto*, to take into account) – the infants' needs and interests by perceiving them and reacting appropriately. To be sensitive in that way makes parents act as supportive companions to their offspring's development.

1.4.3 The Effects of Maintaining Attention and Warm Sensitivity on Infants' Selective Social Learning

Given the empirical findings reported above, it seems possible that Maintaining Attention and Warm Sensitivity might facilitate the development of infants' ability to share others' attention in triadic interactions and, thus, to use others' information in social learning situations. One facet of evidence for the impact of Maintaining Attention and Warm Sensitivity on infants' visual attention to the parent arose from a study in which infants and their parents were provided with age-appropriate toys (e.g., a soft picture book) to induce a joint play situation (Legerstee et al., 2007). In addition to coding the parents' Maintaining Attention and Warm Sensitivity, infants' gazes directed to the parent's face were measured at 3 months of age (i.e. gaze monitoring), and infants' gaze shifts from the toy to the parent's face and back to the same toy (i.e. coordinated attention) were measured at 5, 7, and 10 months of age. Infants' gaze monitoring to the parent at 3 months of age predicted infants' coordinated attention to the parent at 10 months of age only when parents' scores of Maintaining Attention and Warm Sensitivity

were high. That is, high levels of Maintaining Attention and Warm Sensitivity support the relationship between paying visual attention to the parent and the development of infants' coordinated attention as an important ability for social learning in triadic interactions. Furthermore, in another study the effect of Maintaining Attention and Warm Sensitivity on infants' visual attention to the information provided by the parent was investigated (Montague & Walker-Andrews, 2002). In this study, the parental involvement in the interaction with their 3.5-month-old infants was significantly related to infants' sensitivity to the parents' emotional expressions (happy, sad, angry) in a subsequent intermodal preference task. The authors concluded that individual differences in the quality of parent-infant interaction (i.e. parental involvement) are relevant to how infants respond to others' communicative cues (i.e. displayed emotions). In accordance with this study, the influence of Warm Sensitivity and Maintaining Attention on infants' ability to pay visual attention to and use an experimenter's emotional information and attention was investigated (Varghese, 2007). In an initial experiment, the author tested 54 7-month-olds in a teasing task to investigate their attentional reactions when a toy was pulled away from them. Based on a median split, the participants were divided into high- and low-interaction score groups. 66% of the high-interaction score group consistently looked up in all conditions when the toy was pulled away, but only 32% of the low-interaction group did so. This indicates that infants' visual attention in triadic interactions is affected by the level of Maintaining Attention and Warm Sensitivity. In a second experiment, the author tested 50 12-month-olds in a social referencing task to investigate their understanding of the experimenter's positive versus negative emotions towards a target toy. In this experiment, only infants in the high-interaction score group spent more time looking at the target toy – indicating a higher level of visual attention in triadic interactions – and, moreover, demonstrated referential understanding by choosing the appropriate toy in 3 out of 4 conditions, whereas infants in the low-interaction group only did so in one condition.

Remarkably, the reported studies give initial evidence that parents' Maintaining Attention and Warm Sensitivity does not only affect infants' visual attention to the parent (Legerstee et al., 2007) and her/his emotional information (Montague & Walker-Andrews, 2002), but also infants' visual attention to unfamiliar informants and the use of their emotional information (Varghese, 2007). However, further evidence is missing concerning the consistency of these effects for infants in the second year of life. Moreover, there is no knowledge about infants' visual attention to informants and the use of their information when informants provide information different to emotional information. Do these effects of Maintaining Attention and Warm Sensitivity also hold, for example, for information provided in the form of a pointing

gesture or a modeled action? Moreover, does the parents' sensitivity also account for infants' preferences when choosing between a familiar and an unfamiliar informant? One can imagine that a parent's sensitivity affects infants' willingness to choose the parent as a reliable source of information or not. Thus far, there is no evidence for those effects on infants' social learning behavior when two informants differ in their familiarity to infants, reflecting a considerable gap of research in the field of infants' selective social learning. Consequently, more research is necessary in order to investigate whether the quality of parent-infant interaction – in particular Warm Sensitivity and Maintaining Attention as important factors of a parent's sensitivity – accounts for inter-individual differences of infants' selective social learning from familiar and unfamiliar informants.

2. Focus of the Dissertation

The previous introduction clarified that based on an innate motivation to learn about the world around them, infants take others' information into account. This social learning process becomes especially important within infants' second year of life, in which they start to develop a human-unique sense for and motivation to act and think cooperatively when solving a problem (Tomasello, 2009). An important prerequisite here is that infants grow up in a social environment. From birth onwards, infants are accompanied by social partners who often already have a lot of knowledge about the world and, thus, are able to provide useful information. As presented in the previous chapters, in order for a successful information transfer to take place, the infant as recipient needs to take the information into account, which an informant provides in a certain context by means of a medium about an entity in the world. Beginning at around the first year of life, infants start to express motivation to use others' information in a set of social learning abilities, in particular, social referencing, object-directed imitative behavior, and the use of others' referential cues. However, infants in the first year of life already do not take every information from every informant in every context into account, but are rather selective when receiving and using others' information. Studies indicate infants' selectivity in terms of the context of a learning situation, the medium, the entity, as well as the intentionality and voluntariness of a modeled action. Moreover, infants at this young age select certain informants whom they perceive to be more reliable than other informants and, thus, as more relevant in order to solve a problem. Research on infants' selective social learning demonstrates their selectivity in terms of an informant's credibility, accuracy, competence, expertise, and characteristics, like a model's age and group membership. There are additional factors that might influence infants' evaluation of others as reliable sources of information which have not been considered and investigated sufficiently thus far. In particular, it is still an open question in developmental psychology whether infants are selective in terms of the informants' knowledge states that differ based on the informants' local expertise and visual perspective in social learning situations.

To select knowledgeable informants potentially enables a more efficient process of problem-solving and learning, since knowledgeable informants possess relevant information. As indicated by studies about infants' theory of mind, even young infants take different knowledge states of other people in their social environment into account. In line with this, there are studies that we have described above, claiming that infants are selective in terms of an informant's knowledge state about an object (Stenberg, 2009, 2012) or a modeled action (Seehagen & Herbert, 2012) based on the informant's association with the location the experiment takes

place (i.e. local expertise). At the moment, the evidence available for this assumption is restricted to data supporting infants' preference for the unfamiliar informant in the unfamiliar location (i.e. the experimenter in the laboratory). However, further evidence is needed beyond the laboratory location to investigate whether infants prefer the familiar informant in the familiar location (i.e. the parent in the infant's home) and, thus, whether the local-expertise hypothesis is a valid explanation for infants' preference in prior studies. In line with the evidence and assumptions claimed in those studies, we hypothesize that infants selectively receive and use information provided by the local expert, that is, the experimenter in the laboratory and the parent in the infant's home (Study Set 1).

Moreover, there is evidence that infants within their second year of life already take the knowledge states of others based on their visual perspective into account at Level 1 of perspective taking (Brooks & Meltzoff, 2002; Liszkowski et al., 2008; Luo & Baillargeon, 2007; Moll & Tomasello, 2007; Poulin-Dubois et al., 2013; Sodian et al., 2007). However, most of those studies based their inferences only on infants' looking behavior, and none of the studies investigated the behavioral consequences of others' visual perspective on infants' use of others' information. Therefore, it remains unknown whether infants at this age also transfer their own knowledge about others' relevant experiences and, thereby, their own knowledge about others' knowledge onto their own behavior. More specifically, it is still an open question whether infants use others' knowledge based on others' visual perspective for their own selective decisions when learning from reliable others. Given the previous empirical evidence of infants' ability to take others' perspective into account, we hypothesize that infants selectively use more information provided by a knowledgeable informant (i.e. having visual perspective) than by an ignorant informant (i.e. lacking visual perspective) (Study Set *2*).

Furthermore, in addition to an informant's knowledge state, another aspect that is likely to influence infants' evaluation of others as reliable sources of information is their familiarity with an informant. According to attachment theory, parents are important for infants' attachment and development (Bowlby, 1969). On their way to becoming competent, infants use their parents as a secure base. However, do infants actually perceive their parents as more reliable sources of information than unfamiliar informants? The empirical evidence concerning infants' preferences for familiar versus unfamiliar informants is contradictory. On the one hand, there are comprehensible assumptions and empirical pieces of evidence for infants' preference for familiar informants: the importance of familiarity based on the shared experiences beginning in the mother's womb, the explanations given by attachment theory claiming infants' exploration of their environment based on the parent as a secure base, and the studies suggesting infants'

preference for familiar stimuli and informants. On the other hand, however, infants also take into account and prefer unfamiliar over familiar informants when investigating this preference in ambiguous situations, such as in a social referencing paradigm. Moreover, many studies focused on infants within their first year of life and, as such, no consistent findings currently exist for infants in their second year of life. Thus, based on the contradictory findings and the lack of evidence for infants in their second year of life, it is important to further investigate the impact of an informant's familiarity on the selective social learning behavior of infants in their second year of life. Given the relevance of parents for infants' learning and development, we hypothesize that infants selectively look for information from and use information provided by the familiar rather than the unfamiliar informant and thus choose the familiar informant as a more reliable source of information (Study 3).

Thus far we have focused on the selective preference for familiar versus unfamiliar informants for the group of infants. However, it is likely that there are also inter-individual differences that determine infants' selectivity. One factor that might account for such differences is the quality of interaction between parents and their infants. Infants spend their first year of life at home with numerous interactions with their parents, providing a host of interaction experiences. As indicated by studies, parental sensitivity positively affects infants' social and cognitive development. Until now, the construct of sensitivity has often been measured in terms of the parents' reactions to infants' basic needs (i.e. physical and emotional needs). However, when those basic needs are satisfied and when infants develop more mature cognitive and motor abilities to actively acquire knowledge and explore the world around them, it is important to investigate parental sensitivity in terms of appropriate reactions to the infants' interests and focus of attention. As highlighted in a previous chapter, there are two measurements that meet these requirements of sensitivity – Maintaining Attention and Warm Sensitivity. Although a few studies investigated the effects of both variables on infants' social learning behavior (Varghese, 2007; Bono & Stifter, 2003; Landry et al. 1998; Legerstee et al. 2007), further evidence is missing concerning the consistency of these effects for infants in the second year of life. Moreover, there is no knowledge about infants' information reception when informants provide information different to emotional information. In addition, one can imagine that a parent's sensitivity is interrelated with infants' willingness to choose the parent as reliable source of information or not. Consequently, more research is necessary to investigate whether the quality of parent-infant interaction – in particular Warm Sensitivity and Maintaining Attention as important factors of parents' sensitivity – contributes to explain inter-individual differences of infants' selective social learning from familiar and unfamiliar informants. Based

on the evidence of the studies reported above, we would assume 1) positive correlations between the parents' sensitivity and infants' reception and the use of their information (i.e. the more that infants' signals are taken into account by their social environment – mostly reflected by their parents – the more infants are willing to take the signals provided in their social environment into account), and 2) positive correlations between the parents' sensitivity and infants' preference to receive and use more information from their parents than from the unfamiliar informants (i.e. the more that infants' parents take infants' signals into account, the more infants are willing to take their parents' signals into account) (Study Set 4).

To answer these questions is important in order to create more knowledge about the factors that are related to infants' social learning behavior when selecting reliable sources of information. This, in turn, helps to clarify the ontogenetic origins of human development and, thus, helps to create a social environment that is most suitable for young children. To ensure optimal conditions for infants to learn about the world from others means to ensure optimal conditions for transferring cultural knowledge from one to the next generation. This is what motivated the current work about infants' selective social learning.

3. Empirical Studies

In Study Set 1 of the current dissertation we investigated 14-month-old infants in two cross-sectional studies that took place in both the location of the laboratory and the infants' homes. In Study 1a, we presented infants with an exploration task that was designed to investigate infants' selective social referencing. In Study 1b, an imitation task was conducted to collect data about infants' selective imitative behavior. Note, although Study Set 1 was conducted to investigate infants' selectivity due to the informants' knowledge states based on a local expertise, this study set included familiar and unfamiliar informants and, thus, additionally provides first evidence about infants' selectivity due to the informants' familiarity. Subsequent to Study Set 1, we report Study Set 2 which consisted of hiding-finding games that were designed to investigate in two longitudinal studies whether infants at 14 months and 19 months of age (Study 2a) and infants at 14 months and 20 months of age (Study 2b) selectively use others' knowledge based on the informants' visual perspective. More specifically, in Study 2a all of the infants observed two informants who differed in their visual perspective and therefore their knowledge states concerning the hidden object's location. Both the knowledgeable informant (i.e. who saw the object being hidden) and the ignorant informant (i.e. who did not see the hiding of the object) provided different information about the location of the object. In this study, we also investigated infants' use of a physical marker as an abstract referential cue to predict a certain location of the hidden object. In Study 2b, an adjusted version of the hiding-finding game was used to look for differences in the use of informants' indications between infants who observed a knowledgeable informant and infants who observed an ignorant informant. Thereby, we also tested infants' use of a pointing gesture as a concrete referential cue to indicate the location of a hidden object. In accordance with the adjusted version of the hiding-finding game in Study 2b, we investigated infants' selectivity in terms of familiar versus unfamiliar adults as the preferred source of information in a longitudinal design in Study 3. There, infants at 14 months and 20 months of age had to decide within each trial whether to choose the familiar or the unfamiliar informant, which is important to collect data about infants' real decisions rather than mere analytical comparisons of infants' performance in different trials. Moreover, in this study we further investigated infants' information reception in its initial phase, that is, during infants' information search, reflecting their motivation to receive others' information. Finally, Study Set 4 consisted of three cross-sectional studies focusing on the correlation between the quality of parent-infant interaction and the selective social learning of 14-month-old participants. In Study 4a, the aim is to consider possible effects of parents' sensitivity on infants' social referencing behavior. This was done by correlating parents'

sensitivity with infants' performance in the exploration task of Study 1a, that is, their reception of information from both the familiar and unfamiliar informant and the use of the informants' information. In Study 4b, we report connections between the parent-infant interaction and the infants' selective imitative behavior measured in Study 1b. Both Study 4a and Study 4b were conducted in both the laboratory and the infants' homes and, moreover, measured the parent-infant interaction in two appointments. Thus, the results of the two studies can be generalized across both learning contexts and more than just one observation. In Study 4c, we investigated the correlation between the quality of parent-infant interaction and infants' selective preference for familiar versus unfamiliar informants in a hiding-finding game. The interaction variables coded in Study Set 4 were identical and, therefore, the results of the parent-infant interaction can sensibly be discussed across the different paradigms. For an overview of the current study sets see Table 2.

Table 2. *Summary of studies. The table summarizes the number and age of the participants, the tasks that were presented to participants, the locations the studies took place, and the variables that were manipulated in each study.*

Study Set	Study	Task	Participants[1]	*N*	Location	Manipulation
Study Set 1	Study 1a	Exploration	14-month-olds	137	Laboratory & Home	Knowledge State (Local-Expertise) & Familiarity
	Study 1b	Imitation		134		
Study Set 2	Study 2a	Hiding-Finding Game I	14-month-olds	40	Laboratory	Knowledge State (Visual Perspective)
			19-month-olds	30		
	Study 2b	Hiding-Finding Game II	14-month-olds	99	Laboratory	
	Study 3		20-month-olds	77		Familiarity
Study Set 4	Study 4a	Parent-Infant Interaction & Exploration	14-month-olds (of Study Set 1)	78	Laboratory & Home	Familiarity
	Study 4b	Parent-Infant Interaction & Imitation		78		
	Study 4c	Parent-Infant Interaction & Hiding-Finding Game II	14-month-olds (of Study Set 3)	97	Laboratory	

[1] Note that infants of Study Set 1 participated in both Study 1a and Study 1b; infants of Study 2a, Study 2b, and Study 3 each participated in a longitudinal design; Study Set 4 re-analyzed the data of Study Set 1 (Study 4a & Study 4b) and Study 3 (Study 4c) with respect to the observation of parent-infant interaction.

Since our empirical studies are part of the process of the social transfer of information from informants to recipients, we structured our studies based on the adapted Organon model that we explained in the introduction (see section 1.1.1; see Figure 3): In our studies, we investigate the selective social learning behavior of infants by measuring their reception and use of information in the second year of life based on a manipulation of the informants' knowledge states and familiarity, in which the informants send information about certain entities (i.e. novel objects, demonstrated actions, location of a hidden object) by using certain mediums (i.e. facial emotions, demonstrated actions, referential cues) in certain contexts (i.e. the laboratory, the infants' homes). We additionally investigated whether inter-individual differences in infants' social learning behavior are related to the quality of parent-infant interaction.

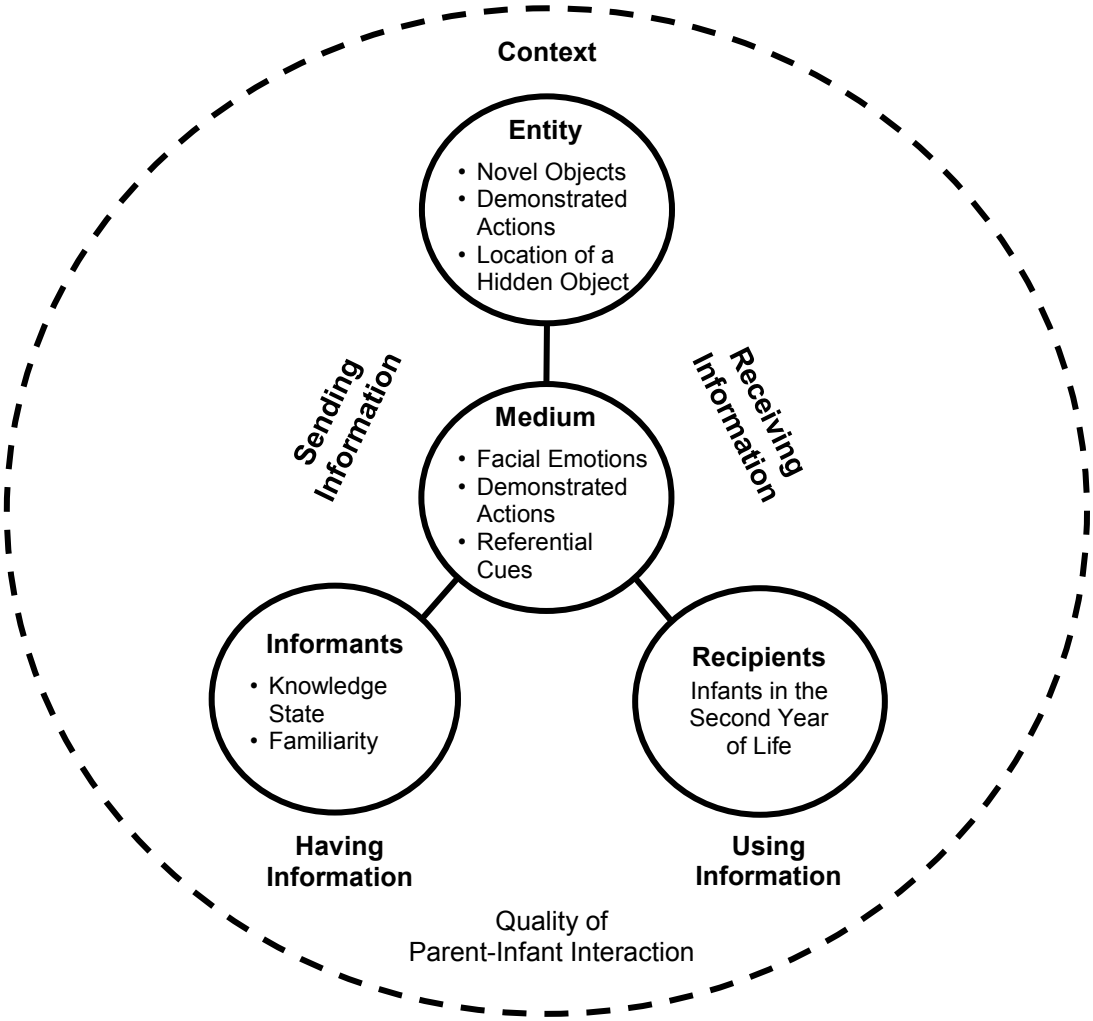

Figure 3. Overview of our empirical studies based on the Organon model.

3.1 Study Set 1: Infants' Selectivity due to Informants' Knowledge States Based on Local Expertise

In order to investigate whether infants distinguish between two informants who differed in their association with a certain location, we presented 14-month-olds in two studies with both an unfamiliar and familiar informant in both an unfamiliar and familiar location. In Study 1a, infants were presented with an exploration task in which both informants evaluated a novel object by displaying positive or negative emotional information. In this task infants' social referencing behavior was measured. In Study 1b, an imitation task was conducted and consisted of two informants who modeled identical actions using different tools. In this task infants' imitative behavior was measured. For an overview of the manipulated variables (i.e. highlighted in green), the mediums and entities, as well as the infants' age, of Study Set 1, see Figure 4.

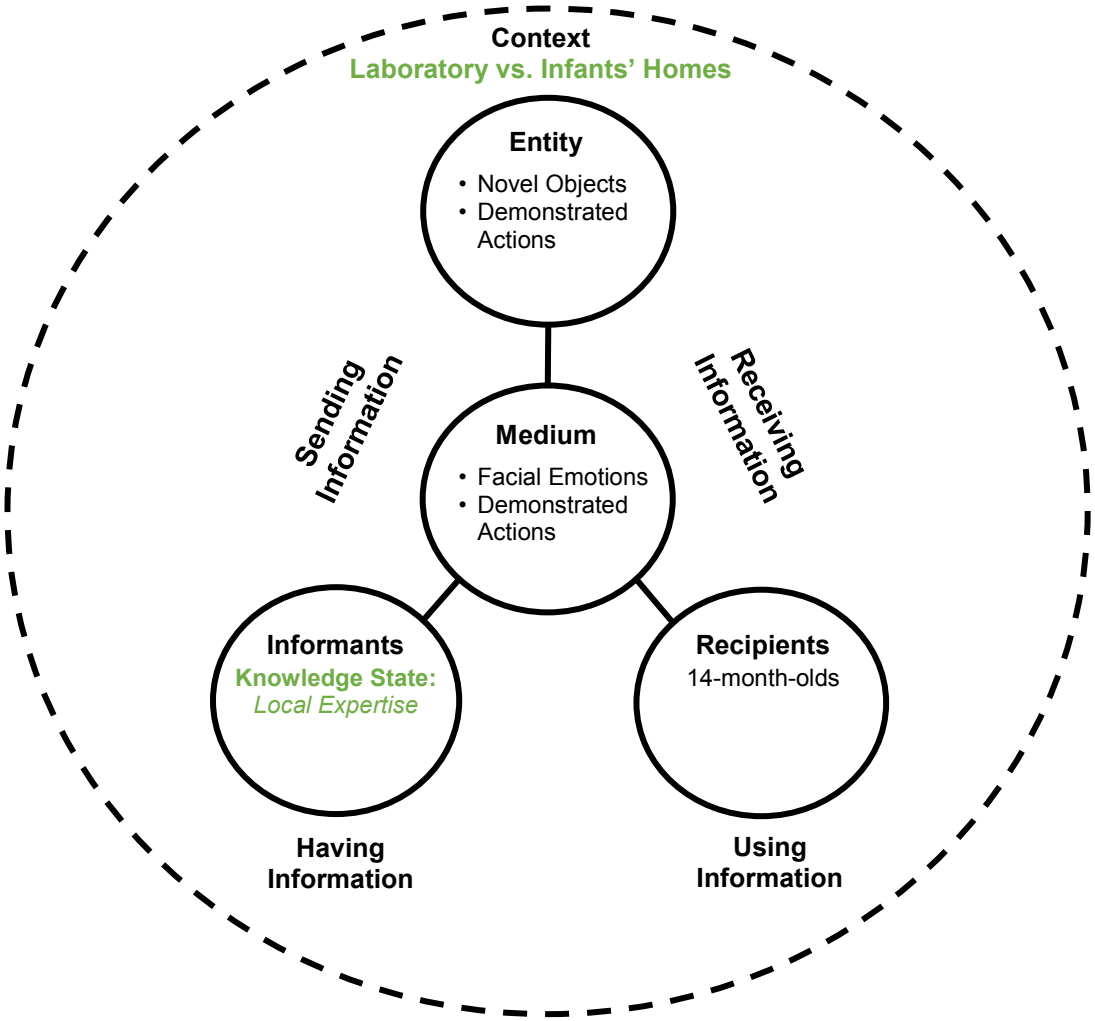

Figure 4. Overview of Study Set 1 based on the Organon model.

3.1.1 Study 1a: Social Referencing

An important and well-known challenge for research in this area is aptly characterizing and explaining the functions of infant social referencing behaviors across a range of environments (Baldwin & Moses, 1996; Klinnert, Campos, Sorce, Emde, & Svejda, 1983). In the current study, we examined 14-month-old infants' performance in a social-referencing task across two locations – the laboratory and the infants' homes. Moreover, in both locations, we presented infants with two sources of information: an *unfamiliar informant* (i.e., the experimenter) as well as a *familiar informant* (i.e., infants' parent), and two kinds of emotional information, both *positive* and *negative*. This allowed us to determine how the (un)familiarity of the informant influences infants' use of emotional information when examining informants and objects. The variation of the informant, the location, and the emotional cues is a crucial advantage in the present study and, thus, represents an important contribution to research investigating the bases of infants' selectivity when evaluating potential informants and the information they provide. Based on the local-expertise hypothesis, we predicted that 14-month-olds predominantly receive and use information from the informant who was associated with the location – the experimenter in the laboratory and the parent in the infants' homes. Regarding the role of emotional expression we expected infants to use the displayed emotions for their exploratory behavior, that is, to explore more when positive emotions are displayed and to explore less when negative emotions are displayed. Moreover, with respect to a possible negativity bias (Vaish, Grossmann, & Woodward, 2008), it is possible that the informants' negative emotions would be more generally influential than positive emotions. For an overview of the manipulated (i.e. highlighted in green) and measured components of Study 1a based on the Organon model, see Figure 5.

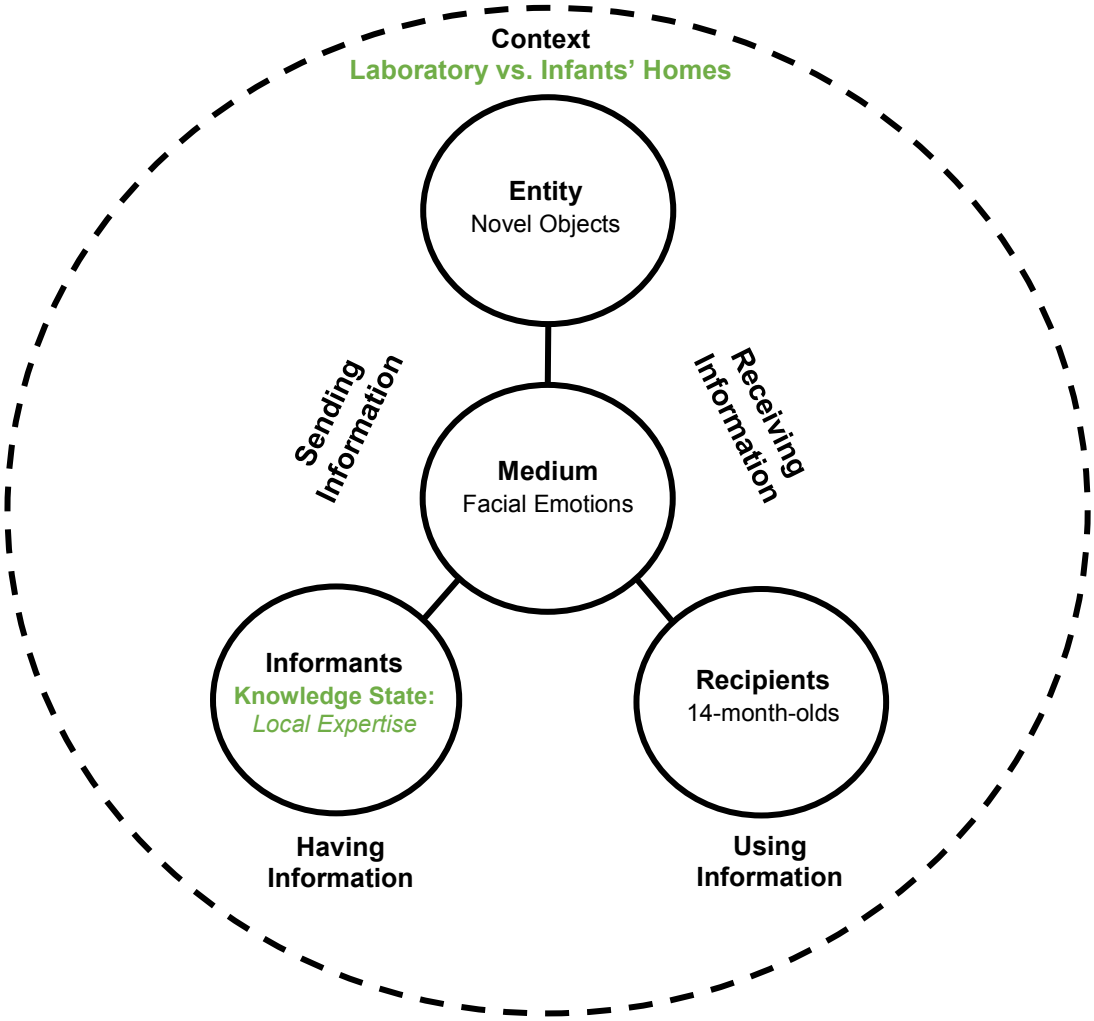

Figure 5. Overview of Study 1a based on the Organon model.

Method

Participants

The sample consisted of 137 infants aged 14 months (mean age = 14 months; 1 day, age range = 13;12 to 14;29, 68 females, 69 males). We tested 67 infants in the laboratory (mean age = 14 months; 0 days, age range = 13;13 to 14;29, 33 females, 34 males) and 70 infants in their homes (mean age = 14 months; 2 days, age range = 13;12 to 14;24, 35 females, 35 males). In addition to the tasks reported here, the same infants also participated in a second session in which we presented them with an imitation task (one week delay; order of exploration and imitation tasks counterbalanced) reported elsewhere. The performance in the exploration task was independent of the order of tasks, so we analyzed the sample as a whole. Three additional infants were tested but excluded from the analyses due to fussiness. Participants were recruited

from a database of parents who had agreed to participate in child development studies in a mid-sized German city. In addition to their general agreement, parents signed a consent form for participating in the current study prior to testing. Each infant received a toy and a certificate for their participation.

Apparatus and stimuli

During the experiment, the infant sat in a fixed chair at a table. The parent and the experimenter sat at the left and the right side of the infant at the same table, opposite to each other. Next to the experimenter's and the parent's chairs there were small chairs with magazines and instruction sheets as reminders of the order and content of each trial. One camera was placed opposite the infant in order to record the infant's gazing behavior and exploratory behavior. A second camera was placed behind the infant to record the infant's exploratory behavior as well as the parent's and the experimenter's acting. On each trial, the experimenter or the parent (i.e., the informants) presented a specifically manufactured and, thus, novel exploration box (5 boxes in total, each 28 cm wide, 15 cm deep, and 7 cm high, see Figure 6), which contained different items (e.g., bubble wrap). While presenting a box, the informants provided positive or negative emotions (except for one neutral trial in which the assistant placed the box on the table, and neither informant provided emotional cues, see below).

Figure 6. Study 1a: The five exploration boxes used as novel objects.

Procedure

According to condition (*laboratory* versus *home*, between-subjects), the experiment took place either in the laboratory or in the infants' homes. In a warm-up phase, the parent filled out a consent form and an assistant played with the infant. In the meantime, the experimenter (same

male adult in both locations) explained the procedure to the parent without mentioning any hypotheses of the study. While the assistant played with the infant, both the parent and the experimenter went to the testing apparatus where the experimenter taught the parent the procedure. This was done since a pilot study revealed the necessity of acting out the procedure with the parent before the test in order to ensure the quality of parents' performance. After this training, the assistant and the infant joined the experimenter and the parent, and the experiment started.

Presentation phase. Infants received four trials which systematically varied by informant (the experimenter or the parent) and by emotional valence toward the box (positive or negative). On one trial, the experimenter presented a box and provided positive emotions; on another trial, he presented another box with negative emotions. On the other two trials, the parent presented another two boxes: on one trail with positive emotions, on the other with negative emotions. The positive emotions consisted of joyful and excited facial and verbal expressions ("Oh! What a funny thing!"[1]), whereas the negative emotions consisted of disgusted and derogatory facial and verbal expressions ("Oh! What a strange thing!"[2]). The parents were asked to display the prescribed emotions as they would naturally do in their everyday interactions with their infants. At the beginning of each trial, the person who presented the box went out of the room, got the box, came back in, and took a seat at the table. The presentation phase started with the informant making the first comment ("Oh! What a funny thing!" with positive affect or "Oh! What a strange thing!" with negative affect) while looking at the box holding it in her/his hands. Afterwards this informant placed the box in the middle of the table, out of the infant's reach. S/he then looked at the box while making comments and displaying emotions either in a positive ("Oh, this is nice! What a great thing! Oh, I really like that!"[3]) or a negative way ("This is weird! What a stupid thing! Ugh, I don't like that!"[4]). After the second and third comment the informant looked at the infant for five seconds in order to maintain the infant's attention (Csibra & Gergely, 2009). The person who did not present the box read a magazine during this phase (Stenberg, 2009). In addition to the four trials which included emotional information, infants received a fifth trial (i.e., the neutral trial) in which both informants read magazines while the assistant placed the box on the table and neither the experimenter nor the parent made any comments about the box or provided emotional cues. For an illustration of the presentation phase, see Figure 7.

[1] Original German wording: "Oh! Was für ein lustiges Ding!"
[2] Original German wording: "Oh! Was für ein komisches Ding!"
[3] Original German wording: "Oh, das ist aber schön! Was für ein tolles Ding! Oh, das gefällt mir sehr gut!"
[4] Original German wording: "Das ist aber seltsam! So ein blödes Ding! Das gefällt mir überhaupt nicht!"

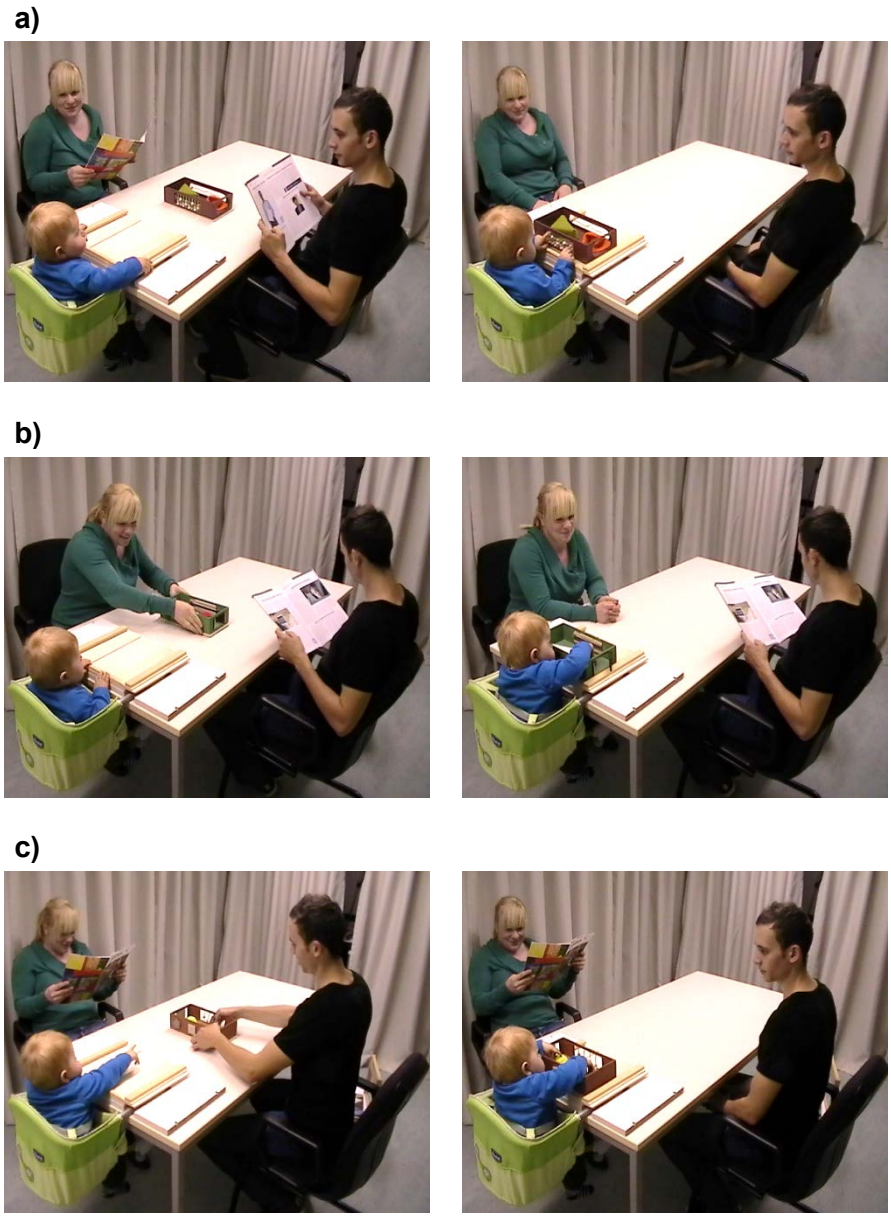

Figure 7. Study 1a: Procedure of the presentation and action phase. The figure shows the presentation phases (left pictures) and infants' subsequent exploratory behavior (i.e. action phase; right pictures) when the box was presented a) in the neutral trial, b) when the parent presented the box, and c) when the experimenter presented the box. The presentation phases b) and c) were conducted in two trials each, one trial with positive and another trial with negative emotions displayed by the presenting informant.

Action phase. After the presentation phase, the presenting informant placed the box on a fixed tray within the infant's reach. Both informants did this simultaneously in the neutral trial. From the moment the box was placed in front of the infant the action phase started, and the infant had the opportunity to explore the box for 60 seconds. In case the infant touched the box before it reached its final position, the trial started with the infant's first touch. After the action phase, the assistant entered the room, took the exploration box and the next trial started with

the presenting person getting the next box. After finishing the experiment, the experimenter, the assistant, the parent, and the infant went back to the play area where the experimenter explained the hypotheses and ideas of the study to the parent. The experiment lasted approximately 15 minutes. The order of the five trials was counterbalanced by having 30 orders varying the combination of the variables informants, emotions, and boxes between participants. The whole session was videotaped. For an illustration of the action phase, see Figure 7.

Manipulation Check

In order to ensure the fit of the emotions that should be displayed by the experimenter and the parent and the emotions that actually were displayed in the study, a research assistant (blind to the provisions of emotions) assigned the informants' emotions to one of three categories (i.e., positive, negative, or neutral). For all trials, the displayed emotions matched the category they belonged to (all rs $\geq .930$, all ps $\leq .001$). The reliability of the evaluation of the informants' emotions was coded from another naïve research assistant for 25% of the participants and resulted in sufficient and high correlations for all trials (all rs $\geq .840$, all ps $\leq .001$). The emotions expressed in 11 trials could not be assigned to the given categories and, therefore, these trials were excluded from the analyses.

Coding and Analyses

Looking behavior. In order to measure infants' looking to the box and to the informants we used a media player to code their looking behavior from the recordings of the first camera for the following two variables: looking time and gaze switches. Looking time (in seconds) was coded whenever the infant looked at one of the following three areas: the parent's face, the experimenter's face, and the box. We then calculated the percentages of looking time for each of the three areas separately. Moreover, we measured infants' joint engagement which is "typically operationally defined by the infant's alternation of gaze between an object and the adult's face" (Carpenter, Nagell et al., 1998, p. 5). Thus, in our study, joint engagement is characterized by the number of gaze shifts infants performed between the box and each of the two informants. More specifically, we measured both the number of gaze switches between the experimenter and the box, and the number of gaze switches between the parent and the box. Both the looking time and the gaze switches were coded during the presentation phase (mean presentation time was 30.3 seconds). Moreover, we coded the looking time at the experimenter and the gaze switches between the experimenter and the box only in those trials in which the experimenter presented the box (because only in those trials the experimenter provided information) and we only coded the looking time at the parent and the gaze switches between

the parent and the box for trials in which the parent was the informant. We additionally analyzed the looking time and the gaze switches in the neutral trial where both informants were available but not providing information in order to get a baseline of infants' looking behavior.

Exploratory behavior. Three measurements of infants' exploratory behavior were coded within the 60-second action phase. We coded (1) the number of seconds infants touched the frame of the exploration box, (2) the number of seconds that infants touched the box's singular functions or elements, and (3) the number of seconds infants spent looking at the box. Note that this measurement of infants' looking time at the box (3) was coded when infants could already act on the box in the action phase and, thus, is different to the one we coded for infants' looking behavior in the presentation phase. We then calculated the exploration time score as a mean of these three exploration measurements. Depending on trial type, we measured exploration time when the experimenter, the parent, and the assistant put the box on the table.

Data reliability

In order to assess inter-rater reliability, a naive research assistant, who was blind to the aims and hypotheses of the study, coded 25% of the sample. The Intraclass-Correlation (ICC) for the inter-rater reliability for the looking time at the experimenter was .983, $p < .001$, it was .973, $p < .001$, for the looking time at the parent, and it was .977, $p < .001$, for the looking time at the box. ICC for the inter-rater reliability for the gaze switches between the experimenter and the box was .855, $p < .001$, and it was .926, $p < .001$, for the gaze switches between the parent and the box. ICC was .985, $p < .001$, for the exploration time when the experimenter presented the box, it was .971, $p < .001$, for the exploration time when the parent presented it, and it was .963, $p < .001$, for the exploration time in the neutral trial. In order to guarantee that all trials were of similar presentation quality we excluded those trials in which the parent or the experimenter made one major mistake or at least three minor mistakes. Major mistakes were counted as cases in which the positive and negative emotions were not distinct ($n = 11$). Minor mistakes were counted as cases in which there were minimal deviations in the wording in the presentation phase ($n = 12$). The ICC for the reliability of the coding of this presentation quality for a quarter of the sample was at least .837, $p < .001$.

Results

Looking Behavior

In order to examine infants' preference for one of the two informants when the informants provided information about the exploration box, we analyzed infants' looking time at both informants, their looking time at the box when the experimenter or the parent presented it, and

their gaze switches between the experimenter and the box and between the parent and the box. Repeated-measures ANOVAs were conducted to examine possible interaction effects between the two informants, their emotional information, and the two locations (laboratory and infants' homes). Note, in the following sections you will find descriptive data only in cases in which the number of participants that were included in the inferential statistics is different to the number of participants that have data in at least one of the two variables which were statistically compared (e.g., in case of paired sample *t* tests). For all the other descriptive statistics see Table 1 and Table 2.

Looking time at the informants. First, we conducted paired-samples *t* tests to investigate whether infants looked more at the experimenter or at the parent when s/he provided information compared to when s/he did not (neutral trial) in order to investigate whether participants indeed paid attention to our manipulation of presenting an object. Infants looked at the experimenter more when he presented the box (M = 45.3% of presentation time, SD = 17.1) than when he did not during the neutral trial (M = 16.1% of presentation time, SD = 11.9), $t(120) = 17.919$, $p < .001$, $d = 1.98$. Infants looked longer also at the parent when the parent presented the box (M = 29.9% of presentation time, SD = 14.9) than when s/he did not during the neutral trial (M = 10.7% of presentation time, SD = 9.2), $t(100) = 12.119$, $p < .001$, $d = 1.55$. Furthermore, we analyzed infants' looking time at the experimenter versus the parent in the neutral trial. There, infants looked significantly longer at the experimenter (M = 16.3% of presentation time, SD = 12.1) than at the parent (M = 10.5% of presentation time, SD = 8.9), $t(124) = 4.284$, $p < .001$, $d = 0.54$.

A repeated-measures ANOVA with informants (the experimenter; the parent) and emotion (positive; negative) as within-subjects factors and location (laboratory; infants' home) as between-subjects factor did not reveal an interaction of informant and location, $F(1,99) = 0.430$, $p = .513$, $\eta^2 = .004$. Moreover, there was neither a main effect of emotion, $F(1,99) = 0.737$, $p = .393$, $\eta 2 = .007$, nor of location, $F(1,99) = 2.957$, $p = .089$, $\eta^2 = .029$. However, there was a main effect for informant, $F(1,99) = 84.363$, $p < .001$, $\eta^2 = .460$, indicating that infants looked significantly longer at the experimenter, $t(100) = 9.189$, $p < .001$, $d = 0.97$, than at the parent, across both locations. For the corresponding bar chart of infants' looking time at the informants across locations, see Figure 8.

Table 3. *Study 1a: Descriptive statistics across emotions. Mean percentages and standard deviations (in italics) of looking time at the experimenter, the parent, and at the exploration box; gaze switches between the informants and the box; and exploratory behavior when the experimenter and when the parent presented the box in the laboratory, the infants' homes, and across locations.*

	Laboratory		**Home**		**Across Locations**	
	Experimenter	**Parent**	**Experimenter**	**Parent**	**Experimenter**	**Parent**
Looking Time at the Informants	49.3 *16.2*	31.8 *15.2*	42.0 *17.4*	28.0 *15.1*	45.5*** *17.2*	29.7*** *15.2*
Looking Time at the Box	29.8 *9.6*	41.9 *14.5*	39.3 *12.9*	48.0 *14.9*	34.7*** *12.4*	45.2*** *14.9*
Gaze Switches	5.7 *2.4*	4.9 *2.7*	5.5 *2.4*	4.9 *2.9*	5.6** *2.4*	4.9** *2.8*
Exploratory Behavior	68.4 *19.2*	72.8 *12.6*	68.9 *20.0*	77.9 *10.6*	68.8** *19.5*	75.5** *11.8*

Note. Differences between both informants across locations: $^{**}p \leq .01$, $^{***}p \leq .001$.

Table 4. *Study 1a: Descriptive statistics according to emotions. Mean percentages and standard deviations (in italics) of looking time at the informants and at the exploration box; gaze switches between the informants and the box; and exploratory behavior when the experimenter (Exp) and when the parent (Par) presented the box in the laboratory, the infants' homes, and across locations as a function of positive (pos) and negative (neg) emotions, as well as when none of the informants presented the box in the control condition by displaying neutral emotions.*

	Laboratory						**Home**						**Across Locations**					
	Exp	**Exp**	**Par**	**Par**	**Exp**	**Par**	**Exp**	**Exp**	**Par**	**Par**	**Exp**	**Par**	**Exp**	**Exp**	**Par**	**Par**	**Exp**	**Par**
	pos	**neg**	**pos**	**neg**	**neutral**		**pos**	**neg**	**pos**	**neg**	**neutral**		**pos**	**neg**	**pos**	**neg**	**neutral**	
Looking Time at the Informants	47.2	51.2	32.0	32.4	18.1	11.7	42.1	42.3	27.3	28.0	14.7	9.4	44.5	46.5	29.5	30.0	16.3	10.5
	16.7	*20.1*	*18.8*	*17.3*	*12.6*	*9.2*	*18.9*	*20.4*	*17.1*	*17.7*	*11.6*	*8.5*	*18.0*	*20.7*	*18.0*	*17.5*	*12.1*	*8.9*
Looking Time at the Box	31.6	28.3	44.0	40.5	22.0		39.8	38.2	49.3	45.7	32.1		35.8	33.5	46.8	43.4	27.4	
	12.1	*11.0*	*19.7*	*16.9*	*14.3*		*15.5*	*16.7*	*18.2*	*18.0*	*18.4*		*14.5*	*15.1*	*19.0*	*17.6*	*17.3*	
Gaze Switches	5.9	5.5	5.1	4.8	2.1	1.3	5.7	5.3	4.7	5.0	2.0	1.4	5.8	5.4	4.9	4.9	2.0	1.4
	3.0	*2.5*	*3.1*	*3.0*	*2.2*	*1.5*	*2.4*	*3.2*	*3.2*	*3.3*	*1.9*	*1.5*	*2.7*	*2.9*	*3.2*	*3.2*	*2.0*	*1.5*
Exploratory Behavior	67.7	67.5	72.8	73.1	43.0		70.8	67.1	75.0	78.7	41.2		69.3	67.3	73.9	76.1	70.1	
	22.8	*24.6*	*17.5*	*17.9*	*13.2*		*21.9*	*23.6*	*16.3*	*13.1*	*13.4*		*22.3*	*24.0*	*16.9*	*15.7*	*22.1*	

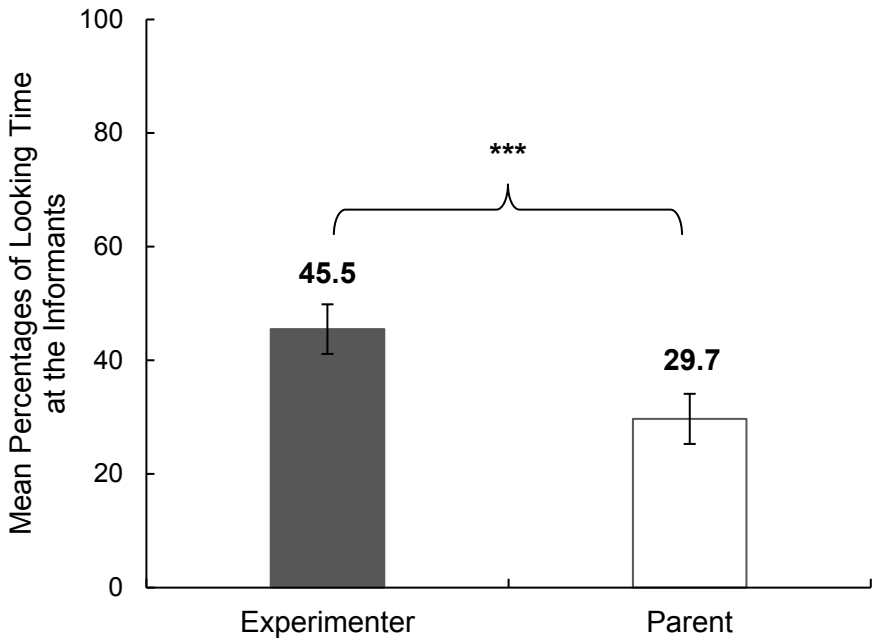

Figure 8. Study 1a: Bar chart of infants' looking time. The graph shows the mean percentages of time that infants looked at both the experimenter and their parent. Significances are highlighted with asterisks based on a paired-samples *t* test comparing infants' looking time at the experimenter with infants' looking time at the their parent. Note: $^{***}p \leq .001$. Error bars show 95% confidence intervals.

Looking time at the exploration boxes. A repeated-measures ANOVA with informant (experimenter; parent) and emotion (positive; negative) as within-subjects factors and location (laboratory; infants' home) as a between-subjects factor did not reveal an interaction of informant and location, $F(1,99) = 0.555$, $p = .458$, $\eta^2 = .006$. However, there was a main effect of emotion, $F(1,99) = 6.824$, $p = .010$, $\eta^2 = .064$, indicating that infants looked longer at the boxes when they were presented with positive emotions ($M = 40.7\%$ of presentation time, $SD = 13.1$) than when they were presented with negative emotions ($M = 37.8\%$ of presentation time, $SD = 13.6$), $t(134) = 2.649$, $p = .009$, $d = 0.22$. There was also a main effect of location, $F(1,99) = 10.311$, $p = .002$, $\eta^2 = .094$, indicating that infants looked longer at the boxes in their homes ($M = 39.5\%$ of presentation time, $SD = 11.9$) than in the laboratory ($M = 30.1\%$ of presentation time, $SD = 10.2$), $t(132) = -4.837$, $p = .000$, $d = 0.84$. Furthermore, there was a main effect of informant, $F(1,99) = 47.033$, $p < .001$, $\eta^2 = .322$, indicating that infants looked longer at the box when the parent presented it than when the experimenter presented, $t(100) = -6.829$, $p < .001$, $d = -0.75$). For mean percentage times, see Table 4.

Gazes switches. First, we conducted paired-samples *t* tests to investigate whether infants switched gaze more between the experimenter and the box or between the parent and the box when s/he provided information compared to when s/he did not (neutral trial) in order to

examine whether participants indeed paid attention to our manipulation of presenting an object. Infants switched gaze more between the experimenter and the box when the experimenter presented the box (M = 5.6 gaze switches, SD = 2.3) than in the neutral trial (M = 2.0 gaze switches, SD = 2.0), $t(120) = 14.400$, $p < .001$, $d = 1.67$, and also more between the parent and the box when the parent presented it (M = 4.9 gaze switches, SD = 2.8) compared to the neutral trial (M = 1.4 gaze switches, SD = 1.5), $t(116) = 13.743$, $p < .001$, $d = 1.56$.

A repeated-measures ANOVA with informant (experimenter; parent) and emotion (positive; negative) as within-subjects factors and location (laboratory; infants' home) as between-subjects factor did not reveal an interaction of informant and location, $F(1,115) = 0.013$, $p = .909$, $\eta^2 = .000$. Moreover, there was neither a main effect of emotion, $F(1,115) = 2.851$, $p = .094$, $\eta^2 = .024$, nor of location, $F(1,115) = 0.062$, $p = .803$, $\eta^2 = .001$. However, there was a main effect of type of informant, $F(1,115) = 8.018$, $p = .005$, $\eta^2 = .065$. Consistent with infants' looking time measurements above, infants more frequently alternated their gaze between the experimenter and the boxes compared to the number of gaze switches between the parent and the boxes, $t(117) = 2.887$, $p = .005$, $d = 0.30$.

Exploratory Behavior

In order to measure how the emotional information of the experimenter and the parent influenced infants' exploratory behavior toward the boxes, we analyzed infants' box exploration during the 60-second action phase that followed the informants' presentations of the boxes. Repeated-measures ANOVAs were conducted to examine possible interaction effects between the two informants, their emotional information, and the two locations of the experiment.

We first conducted paired-samples t tests to check whether infants' exploratory behavior in the four presenter conditions differed from baseline levels during the neutral trial (baseline: M = 69.9% of action time, SD = 22.6). Infants explored the box no differently than baseline levels when the experimenter presented the box with positive emotions, $t(109) = 0.054$, $p = .957$, $d = 0.01$, or negative emotions, $t(110) = -0.323$, $p = .747$, $d = -0.03$ (for descriptive statistics see Table 2). However, infants explored the box more than baseline when the parent presented the box with positive emotions, $t(101) = 2.089$, $p = .039$, $d = 0.21$, or with negative emotions, $t(97) = 2.571$, $p = .012$, $d = 0.27$ (for descriptive statistics see Table 2; baseline level was M = 69.9% of action time, SD = 22.6) We further analyzed for differences in infants' exploratory behavior between positive and negative emotions when the experimenter and when the parent presented the box. There were no differences found for emotional valence, neither for the experimenter, $t(114) = 0.886$, $p = .378$, $d = 0.08$, nor for the parent, $t(92) = -1.162$, $p = .248$, $d = -0.12$.

An omnibus repeated-measures ANOVA with informant (experimenter; parent) and emotion (positive; negative) as within-subjects factors, and location (laboratory; infants' home) as between-subjects factor did not reveal an interaction effect of informant, emotion and location, $F(1,83) = 0.588$, $p = .445$, $\eta^2 = .007$. Moreover, there was neither a main effect of emotion, $F(1,83) = 0.001$, $p = .973$, $\eta^2 = .000$, nor a main effect of location, $F(1,83) = 1.419$, $p = .237$, $\eta^2 = .017$. However, there was a main effect of informant, $F(1,83) = 9.283$, $p = .003$, $\eta^2 = .101$. Infants explored more when the parent presented the box than when the experimenter presented the box, $t(84) = -3.154$, $p = .002$, $d = -0.42$.

Control Analyses

Since previous research suggests that boys are more active than girls when it comes to toy exploration (Goldberg & Lewis, 1969), we also checked for possible gender differences based on independent-samples *t* tests. We did not find gender differences for the time infants spent exploring the boxes when the experimenter presented them, $t(113) = 0.940$, $N_{girls} = 57$, $N_{boys} = 58$, $p = .349$, $d = 0.18$, nor when the parent presented them, $t(91) = 1.860$, $N_{girls} = 44$, $N_{boys} = 49$, $p = .066$, $d = 0.39$. Moreover, there were no gender differences for the gaze switches between the experimenter and the box, $t(127) = -0.834$, $N_{girls} = 63$, $N_{boys} = 66$, $p = .406$, $d = -0.15$, nor between the parent and the box, $t(120) = -1.475$, $N_{girls} = 58$, $N_{boys} = 64$, $p = .143$, $d = -0.27$. However, we did find gender differences in infants' looking time. Girls looked longer at the experimenter ($M = 48.7\%$ of presentation time, $SD = 19.0$) than did boys ($M = 42.4\%$ of presentation time, $SD = 14.8$), $t(127) = -2.094$, $N_{girls} = 63$, $N_{boys} = 66$, $p = .040$, $d = -0.37$. There were no gender differences in looking time spent at the parent, $t(104) = -1.739$, $N_{girls} = 49$, $N_{boys} = 57$, $p = .085$, $d = -0.34$, or at the box, $t(132) = 0.857$, $N_{girls} = 65$, $N_{boys} = 69$, $p = .393$, $d = 0.15$. Since the experimenter was a male adult for all participants, we further analyzed whether there were differences for infants tested with their mothers (differently-gendered informants) and infants tested with their fathers (same-gendered informants). There were no differences for most of the measurements (looking time at the experimenter: $t(114) = 1.173$, $N_{mothers} = 98$, $N_{fathers} = 18$, $p = .243$, $d = 0.29$; looking time at the parent: $t(95) = 1.018$, $N_{mothers} = 82$, $N_{fathers} = 15$, $p = .190$, $d = 0.33$; looking time at the box: $t(119) = -0.708$, $N_{mothers} = 102$, $N_{fathers} = 19$, $p = .480$, $d = -0.18$; gaze switches between the experimenter and the box: $t(114) = -0.489$, $N_{mothers} = 98$, $N_{fathers} = 18$, $p = .626$, $d = -0.13$; exploration time when the experimenter presented the box: $t(104) = -0.494$, $N_{mothers} = 88$, $N_{fathers} = 18$, $p = .623$, $d = -0.15$; and exploration time when the parent presented the box: $t(82) = -0.780$, $N_{mothers} = 71$, $N_{fathers} = 13$, $p = .438$, $d = -0.27$). The only difference that occurred between infants tested with their mothers and those tested with their fathers was in their gaze switches between the parent and the box when the parent

presented the boxes: infants switched their gaze between the parent and the box more often when tested with their fathers (M = 6.3 gaze switches, SD = 2.7) compared to when tested with their mothers (M = 4.7 gaze switches, SD = 2.8), $t(109) = -2.302$, $N_{mothers} = 93$, $N_{fathers} = 18$, $p = .023$, $d = 0.58$.

Furthermore, neither the order of the displayed emotions (i.e., positive emotions first versus negative emotions first) nor the order of the presenting informants (i.e., experimenter first versus parent first) resulted in effects on the dependent variables (independent-samples t tests, all ps ≥ .202 and ≥ .161, all ds ≤ -0.26 and ≤ -0.28 respectively).

Discussion

In this study, we did not find any evidence for the local-expertise hypothesis, neither in infants' looking behavior as an indicator for infants' information reception, nor for infants' exploratory behavior as an indicator for information use. Moreover, there was no effect of location in general on infants' information reception and use. However, we found a main effect of informant for infants' looking behavior in that infants generally looked longer at the unfamiliar experimenter than at their familiar parent. Interestingly, this pattern was reversed for infants' exploratory behavior. There, participants explored the boxes more when the parent presented them than when the experimenter presented them.

One might wonder whether both infants' looking behavior and their exploratory behavior might also reflect alternative motivations besides the motivation to receive (looking behavior) and use (exploratory behavior) the information provided by the informants. For example, it is possible that infants look at others simply in order to engage with them and that they explore the boxes merely to gain information about them. However, based on previous research on infants' social referencing (Feinman et al., 1992; Hornik et al., 1987; Stenberg, 2009, 2012, 2013; Stenberg & Hagekull, 1997, 2007; Walden & Kim, 2005) we interpret participants' looking behavior within the presentation phase as evidence of their interest in information about the box, and we take the extent of participants' exploratory behavior as evidence of their use of the emotional information the informants directed to the box. In addition, irrespective of what various factors exactly motivated the infants' actions in the current study, we wanted to investigate whether the informants' local expertise had an influence on those actions.

Other than the effects of the informant's familiarity on infants' exploratory behavior, displayed emotions had no effect on infants' exploratory behavior in the current study. One might wonder whether infants recognized the differences between the displayed emotions (positive/negative) at all, and whether they understood their valence and directedness. That the displayed emotions were different in terms of their valence can be assumed from the

manipulation check reported above. Moreover, infants showed differences in gazing behavior depending on the informants' emotions: They looked longer at the box when positive emotions were displayed than when negative emotions were displayed (independent of who presented them). Thus, infants did recognize differences between the displayed emotions, and even possibly their directedness and their valence, as did young infants in previous studies (Carver & Vaccaro, 2007; Hertenstein & Campos, 2004; Kahana-Kalman & Walker-Andrews, 2001; Klinnert, 1984; Klinnert et al., 1986; Kobiella et al., 2008; Moses et al., 2001; Mumme & Fernald, 2003; Mumme et al., 1996; Repacholi, 1998; Rosnay et al., 2006; Serrano et al., 1993; Sorce et al., 1985; Walker-Andrews & Dickson, 1997). However, they did not include this information in their own action planning and execution. One reason for this could be that they assessed the informants' evaluations of the box as subjective attitudes that did not affect their own evaluation of the box (see Zmyj et al., 2010, for a similar argumentation for 14-month-olds' lack of selectivity in an object-choice task). Another reason might be that the negative emotions shown in the current study (e.g., dislike and disgust) were not sufficiently salient or meaningful enough to infants as would have been other, more alerting emotions such as anger or sadness (Nelson, 1987; Repacholi & Gopnik, 1987). Although we cannot rule out this possibility, we did not use more alerting emotions because, first, we did not want to threaten the participants, and second, it is known that even younger infants recognized emotions highly similar to the emotions displayed in the current study (Stenberg, 2013; Walden & Kim, 2005).

In conclusion, our study contributes important new empirical evidence to our understanding of infants' selective social learning. Although our results do not support the local-expertise hypothesis in 14-month-olds', our findings suggest that infants at this age are nevertheless selective in their reception and use of information. When provided with information about a novel object they prefer to look at an unfamiliar rather than a familiar informant. However, when it comes to the use of information, that is, the active manipulation of the novel object, infants explored the object more when presented by a parent. This dissociation between the factors that influence information reception and use was robust across different kinds of emotions and locations and demonstrates the role played by informants' familiarity on the nature of infants' social referencing.

3.1.2 Study 1b: Imitative Behavior

In the current study, we wanted to clarify whether or not infants' information reception and imitation of others depended on the association of an informant with a certain learning context. For this, we observed 14-month-old infants' performance in an imitation task in two locations, the laboratory and the infants' homes. In both locations, we presented infants with both an *unfamiliar model*[5] (i.e. the experimenter) and a *familiar model* (i.e., infants' parent). The variation of both the informants' familiarity as well as the location of the experiment, and the inclusion of a large number of participants constitutes a significant advantage of the present study over the previous research. Based on the local-expertise hypothesis, we predicted that 14-month-olds would predominantly look at and imitate the model who is associated with the location – the experimenter in the laboratory and the parent in the infants' homes. For an overview of the manipulated (i.e. highlighted in green) and measured components of Study 1b based on the Organon model, see Figure 9. Note that for the imitative behavior of infants, the action demonstrated by the informants reflects both the medium by which and the entity about which an informant provides information.

[5] In the present study, we use the term *model* as equivalent to the term *informant*.

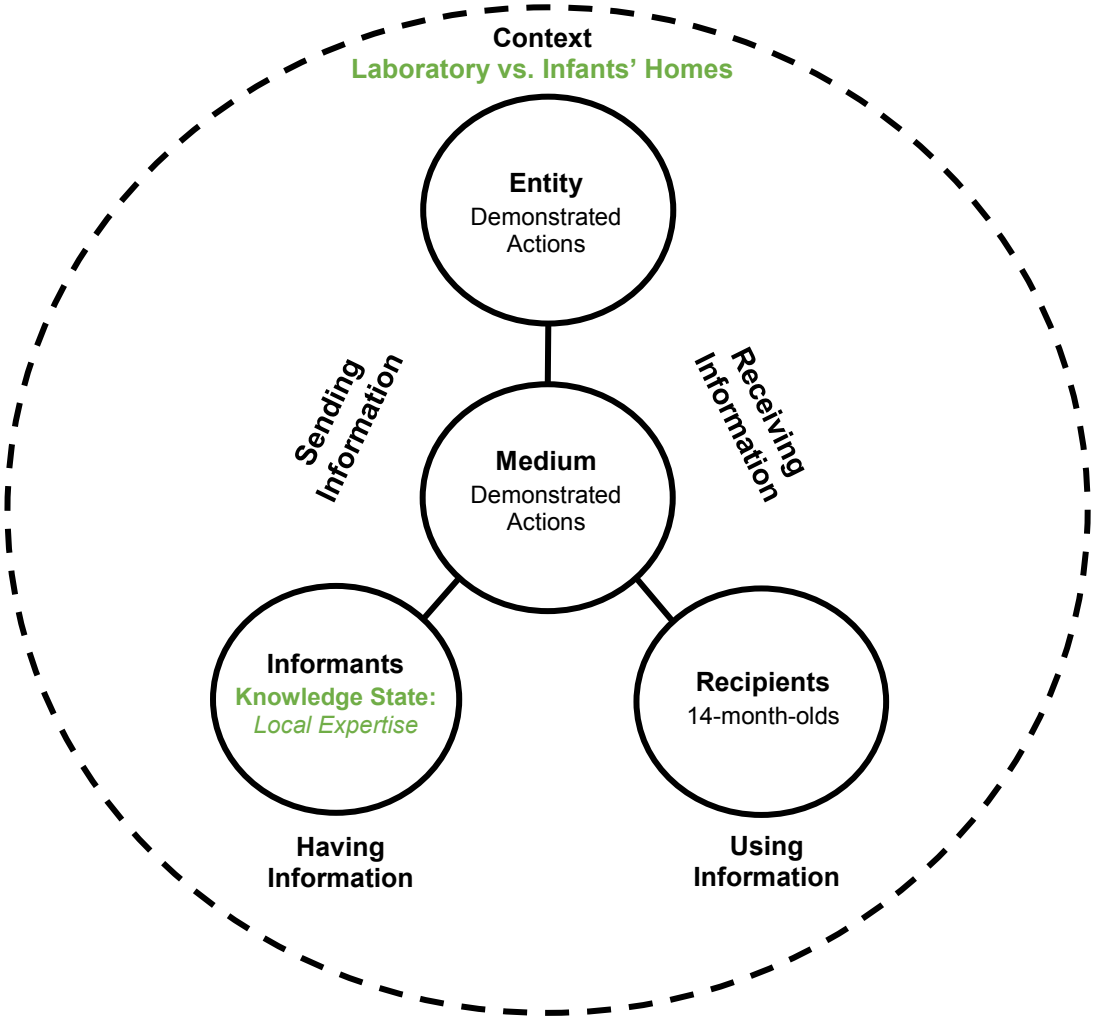

Figure 9. Overview of Study 1b based on the Organon model.

Method

Participants

The sample consisted of 134 infants at an average age of 14 months (mean age = 14 months; 1 day, age range = 13;10 to 14;29, 63 females, 71 males). We tested 65 of these infants in the laboratory (mean age = 14 months; 0 days, age range = 13;13 to 14;29, 30 females, 35 males) and 69 of these infants in their homes (mean age = 14 months; 2 days, age range = 13;10 to 14;24, 33 females, 36 males). Six additional infants were tested but excluded from the analyses due to fussiness. We recruited participants from a database of parents who gave us their consent to participate in child development studies in a mid-sized German city. Prior to testing, parents signed a consent form for participating in the current study. Each infant received a certificate and a toy to thank them for their participation. In addition to the tasks reported here, infants

participated in a second session at which we presented them with another task (one week delay; order of tasks counterbalanced). The performance in the imitation task was independent of the order of tasks, so we analyzed the sample as a whole.

Apparatus, stimuli, and procedure

The experiment took place either in the laboratory or in the infants' homes (*laboratory* versus *home condition*, between-subjects). In a familiarization phase, the parent filled out a consent form and the assistant played with the infant. Meanwhile, the experimenter explained the procedure to the parent without mentioning any hypotheses of the study. Thereafter, the experimenter taught the parent the procedure out of infants' view while the assistant was still playing with the infant. This was done based on the experiences we made in a pilot study indicating the necessity of acting out the procedure with the parent before the test phase in order to ensure the quality of the parent's performance. Following this training, the infant and the assistant joined the experimenter and the parent in the testing room, and the experiment started. For the experiment, the infant sat at a table in a fixed chair. The experimenter and the parent sat at the right and the left sides of the infant at the same table, opposite each other (the side of the experimenter and the parent was counterbalanced between subjects). Next to the chairs of the experimenter and the parent there were small chairs with magazines and instruction sheets on them. These instruction sheets were helpful for the parent in order to keep in mind the order and content of each trial. One camera was placed opposite the infant in order to record the infant's imitative behavior. A second camera was placed behind the infant to record the infant's imitative behavior as well as the experimenter's and the parent's acting. In each trial, the experimenter or the parent (i.e., the models) presented a novel imitation set (see Figure 10) that consisted of an object (set 1: a toy pig, 25 cm wide, 7 cm deep, and 8 cm high; set 2: a toy keyboard, 48 cm wide, 14 cm deep, and 2.5 cm high; set 3: a bell, 5.5 cm wide, 5.5 cm deep, and 3.5 cm high) and two tools (set 1: brush, 27,5 cm long, and spoon, 31,5 cm long; set 2: green and blue wooden stick, each 27,5 cm long; set 3: aluminum & plastic trowel, each 31 cm long) on a tray (44 cm wide, 59 cm deep, and 2 cm high).

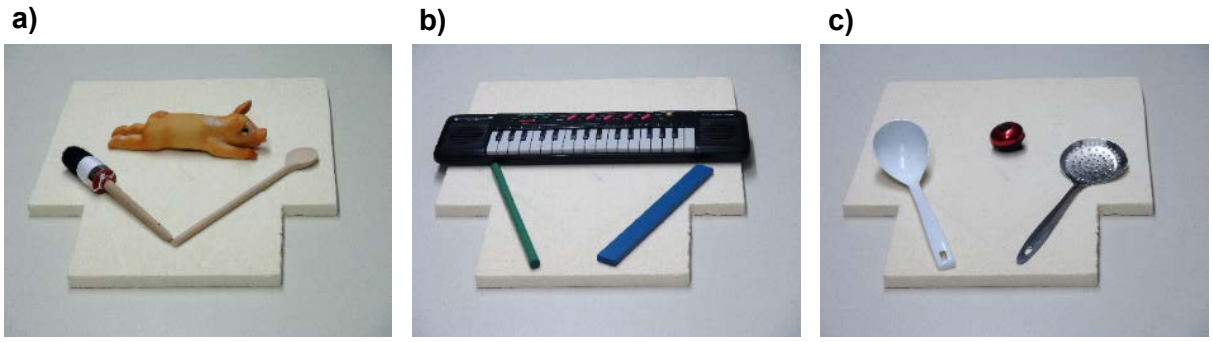

Figure 10. Study 1b: Materials of the imitation task. Each imitation set used in this study consisted of a target object and two different tools used by the models to elicit a sound from the target object.

Demonstration Phase. Infants received a total of three trials. In two of these trials, the models placed the imitation sets in the middle of the table, out of the infant's reach, while commenting on them positively for 30 seconds (in one trial the experimenter presented an imitation set, in another trial the parent presented an imitation set). In a third trial, the assistant placed the imitation set on the table while both models read magazines and did not make any comments.[6]

In each trial, both models used different tools to operate a target object one after the other. The presenter of the imitation set started to model the action. In the trial with no presenter the order of models was counterbalanced between subjects. The first model took the tool in front of her/him and pushed it on the target object (toy pig and toy keyboard, see Figure 2 a and b) for one second or tapped on the target object three times (bell, see Figure 2 c), which elicited a sound effect. Then, the model put back the tool, and the other model demonstrated the exact same action eliciting the same sound effect while using the other tool (i.e., the one in front of her/him). Thus, both demonstrations did not differ in respect to duration or effect, they only differed with respect to the tool used. This demonstration was repeated three times in each trial. The position of the tools was counterbalanced between subjects. The mean modulation time was 31.5 seconds.

Action phase. Following the demonstration phase the presenter moved the base with the materials on it towards the infant (both models did this simultaneously in the trial with no presenter), such that both tools were within the infant's reach but the target object itself was not. This created the necessity for infants to use the tools in order to elicit the effect from the target object. From the moment the imitation set was placed in front of the infant the action

[6] Since the variation of who presented the object was neither the focus of this study nor had any effect on participants' response behavior, we will ignore this methodological variation in the following.

phase started, and the infant had the opportunity to act on the imitation set for 30 seconds. In case the infant touched the tools before it reached its final position, the action phase started at the moment of the infant's first touch. After the action phase, the assistant entered the room, put away the tray with the imitation set, and the next trial started. After the experiment, the experimenter, the assistant, the parent, and the infant went back to the play room. There, the experimenter explained the hypotheses of the study to the parent. The experiment lasted approximately 10 minutes. The order of the imitation sets was counterbalanced between participants. The whole session was videotaped. For an illustration of both the demonstration and action phase, see Figure 11.

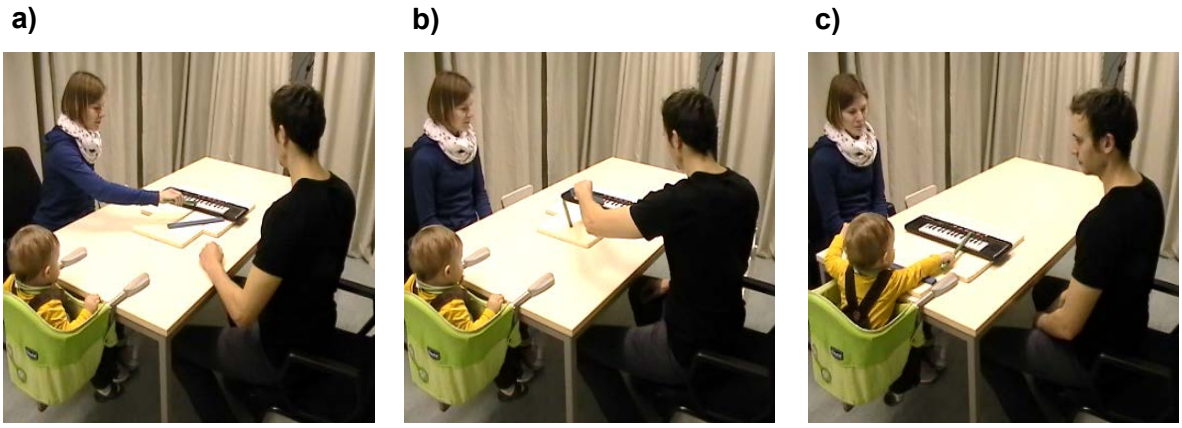

Figure 11. Study 1b: Modulation and imitation phase. The figure shows the modulation phase in which a) the parent and b) the experimenter demonstrated the very same action by using different tools. In this example, the parent used a green wooden stick (parent tool), whereas the experimenter used a blue wooden stick (experimenter tool) to push a key on the toy keyboard eliciting a sound effect. Subsequently, we measured c) the infant's imitative behavior by focusing on their tool choice.

Coding and Analyses

Looking Behavior. In order to measure infants' looking at the models we used a media player to code their looking behavior from the recordings of the first camera for the following two variables: looking time and joint engagement. Looking time (in seconds) was coded whenever the infant looked at the parent's face or the experimenter's face. We then calculated the percentages of looking time for each of the two areas separately. Moreover, we measured infants' joint engagement by the number of gaze switches infants performed between the object and each of the two models (Carpenter, Nagell et al., 1998). Thus, we measured both the number of gaze switches between the experimenter and the object, and the number of gaze switches between the parent and the object. Both infants' looking time and infants' joint engagement were coded during the demonstration phase.

Imitative Behavior. Infants' imitative behavior was measured within the 30-second action phase. We coded as imitation "any executed behavior that matches the demonstrated one" (Zmyj & Buttelmann, 2014, p. 22; Paulus, Hunnius, Vissers, & Bekkering, 2011), that is infants touching the target objects with a tool. First, we coded which tool ('1' = experimenter tool, '2' = parent tool) infants used first (*first use*) for each trial. Second, for each trial we coded whether infants used a tool at all (*general use*) for both tools separately (experimenter tool and parent tool). We coded '1' if participants used the tool and '0' if they did not. For analyses of the first trial, we analyzed those two variables (*first use* and *general use*) to gain insight into infants' spontaneous imitative behavior. For the overall analyses of those variables, we calculated the mean percentages of trials in which participants used each tool first (*first use*) and at all (*general use*).

Data reliability

In order to assess inter-rater reliability, a naive research assistant, who was blind to the aims and hypotheses of the study, coded 25% of the sample. The Intraclass-Correlation (ICC) for the inter-rater reliability for the variables of infants' looking behavior was at least .954, $p < .001$. Moreover, by using Cohen's Kappa (first trial) and ICC (across all trials) we found high correlations for all the variables for both types of analyses, across all trials (general use of the parent-tool: ICC was .958, $p < .001$, general use of the experimenter-tool: ICC was .906, $p < .001$; first use of the parent-tool: ICC was .964, $p < .001$; first use of the experimenter-tool: ICC was .892, $p < .001$) as well as for the first trial (general use of the parent-tool: $k = .940$, $p < .001$, general use of the experimenter-tool: $k = .927$, $p < .001$; first use: $k = .938$, $p < .001$). In order to ensure that all trials were of identical presentation and modulation quality, we coded the experimenter's and the parent's performance. We excluded those trials in which the parent or the experimenter made at least one major mistake. As major mistakes we counted cases in which the presenters' emotions were not positive or her/his comments during the object presentation did not match the ones given ($n = 5$ trials) or cases in which a model did not or not sufficiently elicit the effect with the tool ($n = 15$ trials). Another 19 trials had to be excluded due to infants' fussiness. Finally, 363 out of 402 possible trials could be analyzed. The ICC for the reliability of the coding of this presentation quality for a quarter of the sample was at least .927, $p < .001$.

Results

Looking Behavior

First Trial. For infants' looking time, a repeated-measures ANOVA did not reveal an interaction effect between model and location, $F(1,133) = 0.053$, $p = .818$, $\eta^2 = .000$. However, there was a model effect for infants' looking time, $F(1,133) = 15.647$, $p < .001$, $\eta^2 = .105$, indicating that infants looked longer at the experimenter ($M = 5.3\%$ of time, $SD = 5.6$) compared to the parent ($M = 3.3\%$ of time, $SD = 4.6$). Moreover, there was also an effect of location, $F(1,133) = 7.155$, $p = .008$, $\eta^2 = .051$, indicating that infants looked longer at the models in the laboratory ($M = 10.5\%$ of time, $SD = 11.5$) than they did at infants' homes ($M = 6.8\%$ of time, $SD = 8.6$). Similarly, for infants' gaze switches, there was no interaction effect between the model and the location, $F(1,132) = 2.341$, $p = .128$, $\eta^2 = .017$, and no model effect, $F(1,132) = 0.300$, $p = .585$, $\eta^2 = .002$. However, there an effect of location for infants' gaze switches in the first trial, $F(1,132) = 11.256$, $p = .001$, $\eta^2 = .079$, indicating that infants switched more gazes between the models and the object in the laboratory ($M = 4.1$ gaze switches, $SD = 4.4$) than in the infants' homes ($M = 2.3$ gaze switches, $SD = 3.4$).

Across all trials. A repeated-measures ANOVA did not reveal an interaction effect between model and location for infants' looking time, $F(1,127) = 0.311$, $p = .578$, $\eta^2 = .002$. However, there was a model effect for infants' looking time, $F(1,127) = 18.144$, $p < .001$, $\eta^2 = .125$, indicating that infants looked longer at the experimenter ($M = 3.8\%$ of time, $SD = 3.3$) compared to the parent ($M = 2.5\%$ of time, $SD = 2.8$). Moreover, there was also an effect of location, $F(1,127) = 6.424$, $p = .012$, $\eta^2 = .048$, indicating that infants looked longer at the models in the laboratory ($M = 7.4\%$ of time, $SD = 7.0$) than they did at infants' homes ($M = 5.2\%$ of time, $SD = 4.9$). Similarly, for infants' gaze switches, although at trend level, there was also no significant interaction effect between the model and the location, $F(1,114) = 3.235$, $p = .075$, $\eta^2 = .028$ (see Table 3 for the direction of this trend). Moreover, there was again a model effect, $F(1,114) = 150.253$, $p < .001$, $\eta^2 = .569$, indicating that infants switched more gazes between the experimenter and the object ($M = 1.1$ gaze switches, $SD = 0.5$) than between the parent and the object ($M = 0.4$ gaze switches, $SD = 0.4$). However, there was no effect of location for infants' gaze switches, $F(1,114) = 0.000$, $p = .993$, $\eta^2 = .000$. For descriptive data of infants' looking behavior across all trials see Table 5.

Table 5. *Study 1b: Descriptive statistics of infants' looking behavior. Mean percentages and standard deviations (in italics) of infants' looking time at the experimenter (Exp) and the parent (Par), as well as infants' gaze switches between the models and the objects in the laboratory, the infants' home, and across locations across all trials.*

	Laboratory		**Home**		**Across Locations**	
	Exp	**Par**	**Exp**	**Par**	**Exp**	**Par**
Looking Time at the Models	4.4 *3.7*	3.0 *3.3*	3.2 *2.7*	2.0 *2.2*	3.8*** *3.3*	2.5*** *2.8*
Gaze Switches	1.1 *0.5*	0.4 *0.4*	1.2 *0.5*	0.3 *0.4*	1.2*** *0.5*	0.4*** *0.4*

Note. Differences between both informants across locations: ***$p \leq .001$.

Imitative Behavior

First trial. We conducted Chi-square tests to check for differences in infants' imitative behavior in the first trial between both locations. These analyses did not reveal any differences, neither for the general use of the tools, $\chi^2 = 3.055$, $N = 42$, $p = .081$, nor for the first use of the tools, $\chi^2 = 3.049$, $N = 70$, $p = .081$. Therefore, for the investigation of infants' preference of the parent-tool versus the experimenter-tool both locations were combined. The number of infants who used only the parent-tool ($n = 28$) was significantly higher than the number of infants who used only the experimenter-tool in the first trial ($n = 14$), McNemar test, $N = 122$, $p = .044$. Finally, this pattern was present also for the infants' first use of the tools: Significantly more infants used the parent-tool ($n = 45$) than the experimenter-tool ($n = 25$), Binominal test, $N = 70$, $p = .022$. See Table 6 for an overview of the descriptive data for the first trial.

Across all trials. A repeated-measures ANOVA did not reveal an interaction effect between model and location for the general use of the tools, $F(1,132) = 0.341$, $p = .560$, $\eta^2 = .003$. Moreover, for the general use of the tools there was no model effect, $F(1,132) = 0.017$, $p = .896$, $\eta^2 = .000$, and no effect of location, $F(1,132) = 2.105$, $p = .149$, $\eta^2 = .016$. Similarly, there was no interaction effect between the model and the location for the tool participants used first across all trials, $F(1,132) = 0.798$, $p = .373$, $\eta^2 = .006$. Additionally, we neither found a model effect, $F(1,132) = 0.069$, $p = .793$, $\eta^2 = .001$, nor an effect of location for the tool used first across all trials, $F(1,132) = 0.374$, $p = .543$, $\eta^2 = .003$. See Table 6 for an overview of the descriptive data across all trials.

Table 6. *Study 1b: Descriptive statistics of infants' imitative behavior. Number of infants (first trial) who, and mean percentages of trials (overall trials) with standard deviations (in italics) in which infants, used first the parent-tool and the experimenter-tool, used only the parent tool (Par), only the experimenter tool (Exp), both tools (Both), or no tool at all (None) in the first trial and overall trials as a function of location.*

		Laboratory				**Home**				**Across Locations**			
		Exp	**Par**	**Both**	**None**	**Exp**	**Par**	**Both**	**None**	**Exp**	**Par**	**Both**	**None**
First Trial	First Use	16	19	-	-	9	26	-	-	25*	45*	-	-
	General Use	10	12	13	23	4	16	15	29	14*	28*	28	52
Overall Trials	First Use	33.1 *33.3*	27.7 *32.2*	-	-	31.1 *35.0*	34.1 *35.6*	-	-	32.1 *34.2*	30.9 *33.9*	-	-
	General Use	17.6 *26.3*	19.2 *28.9*	23.8 *34.8*	39.2 *41.8*	15.2 *24.9*	12.8 *25.2*	37.2 *38.1*	34.8 *42.2*	16.4 *25.6*	16.0 *27.1*	30.5 *36.5*	37.0 *42.0*

Note. Differences between infants using the experimenter tool and infants using the parent tool across locations: $^{*}p \leq .05$.

Control Analyses

For infants' looking behavior no significant differences between infants' gender were found, neither for the looking time (independent-samples *t* tests, across all trials: all *p*s ≥ .077, all *d*s ≤ 0.31, first trial: all *p*s ≥ .068, all *d*s ≤ 0.31), nor for the gaze switches (independent-samples *t* tests, across all trials: all *p*s ≥ .150, all *d*s ≤ 0.25, first trial: all *p*s ≥ .137, all *d*s ≤ 0.26). Since the experimenter was a male adult for all participants, we further analyzed whether there were differences for infants tested with their mothers (differently-gendered models, 117 infants) and infants tested with their fathers (same-gendered models, 17 infants). There were no differences between different-gendered and same-gendered models for none of the variables of infants' looking behavior, neither for the looking time (independent-samples *t* tests, across all trials: all *p*s ≥ .431, all *d*s ≤ 0.23, first trial: all *p*s ≥ .771, all *d*s ≤ 0.09), nor for the gaze switches (independent-samples *t* tests, across all trials: all *p*s ≥ .067, all *d*s ≤ 0.15, first trial: all *p*s ≥ .568, all *d*s ≤ 0.17). Moreover, there were no gender differences across all trials with respect to the general use of the parent-tool, $t(132) = -0.814$, $N_{girls} = 63$, $N_{boys} = 71$, $p = .417$, $d = 0.14$, and the experimenter-tool, $t(132) = -1.751$, $N_{girls} = 63$, $N_{boys} = 71$, $p = .082$, $d = 0.30$. Although there was further no gender difference across all trials in terms of the first use of the experimenter-tool, $t(132) = 1.808$, $N_{girls} = 63$, $N_{boys} = 71$, $p = .073$, $d = 0.31$, there was a difference between infants' gender concerning the first use of the parent-tool, $t(132) = 2.435$, $N_{girls} = 63$, $N_{boys} = 71$, $p = .016$, $d = 0.42$, indicating that boys used the parent-tool as the first tool more often (M = 37.6% of trials, $SD = 35.3$) compared to girls (M = 23.5% of trials, $SD = 31.1$). Regarding the first trial analyses we did not find any gender differences for none of the variables (Chi-square tests, all *p*s ≥ .099). Moreover, there were no differences between different-gendered and same-gendered models for none of the variables of infants' imitative behavior across all trials (independent samples *t* tests, all *p*s ≥ .130, all *d*s ≤ 0.48) as well as for the first trial (Chi-square tests, all *p*s ≥ .117).

Discussion

In this study, we did not find an interaction effect between the model and the location when observing infants' looking and imitative behavior, neither for the first trial nor for the analysis across all trials. For infants' looking behavior, we found a preference for looking at the experimenter for both the measurement of infants' looking time and infants' joint engagement. Thus, infants in both locations looked longer at the experimenter than at the parent, and they also showed more joint engagement with the experimenter than the parent. In other words, when both the experimenter and the parent provided infants with information by modeling an action

on an object, infants received more information from the experimenter than from their parent. This preference tended to be even stronger in the laboratory than in the infants' homes for the joint engagement across all trials. Accordingly, we obtained a location effect for infants' looking time and joint engagement, indicating that infants looked longer and showed joint engagement more in the laboratory than in the infants' home. This might be explained by infants' increased attention in unfamiliar locations.

Initially, the analyses of the infants' first imitative reaction (the first trial) did not demonstrate that the experiments' location had any effect. However, infants preferred to spontaneously imitate the action modeled by the parents over that of the experimenter, since significantly more infants used the tool with which the parent modeled the action in the first trial. Interestingly, there was no significant main effect of the type of model across all trials: Infants did not imitate one model more than the other one across both locations. Finally, there was also no significant main effect of locations across all trials: Infants did not imitate more in one location than in the other. Focusing on the first trial, 14-month-olds seem to have a spontaneous preference for imitating their parents over strangers, regardless of the familiarity of the learning context. This difference in infants' imitative behavior in the very first trial shows that the lack of a difference across all trials is not a result of the task we used.

The infants' predominant use of the tool modeled by the parents in the very first trial might, at least to some extent, have been caused by participants' uncertainty in the novel test situation. This hypothesis is supported by the finding that a relatively high number of infants did not use any of the tools in the first trial (52 out of 122 infants, across locations). Moreover, when infants had to make an initial decision for using one of the two tools, it is possible that they showed a preference for the tool used by the familiar model because this model represented a secure source of information for them. As the process of the experiment continued, infants started to use the tool used by the unfamiliar person, which, finally, resulted in an equal use of both tools across trials.

Given 14-month-olds' preference for in-group versus out-group members when learning new means to operate a novel apparatus (Buttelmann et al., 2013), one might have expected participants in the current study to predominantly imitate the actions modeled by the familiar model (i.e., their parents) even across numerous trials. This would have refrained them, however, from also learning the function of the tool used by the unfamiliar model. In contrast to this expectation, infants did not show a decrease in willingness to learn an action from models other than their own mothers or fathers, and this indifference in willingness was independent from the location the experiment took place. Thus, the infants in our study made use of the full

learning potential the situation provided. This potential was to learn to operate an apparatus by using different tools in different locations. Using this potential was possible only by resisting the (possible) influence of the familiarity of the models (or the location). The fact that infants did not prefer to imitate their parents over the experimenter across all trials suggests that only a stark cue such as the model being a member of a different, unfamiliar language group leads to a decrease in infants' willingness to imitate (Buttelmann et al., 2013).

To conclude, our study did not provide any evidence for the local-expertise hypothesis. However, the study shows that infants at 14 months of age received more information from the unfamiliar than the familiar model when both models demonstrated an action on an object. In contrast, participants spontaneously preferred to imitate familiar models over unfamiliar models. This preference, however, seems to be highly fragile and limited to the very first learning instance. Across all trials, infants imitated the modeled action from both social informants by using both tools in both locations. This challenges – in combination with the results of infants' looking behavior – the local-expertise hypothesis: Instead of associating models with locations and taking this association as a basis for deciding whether to socially learn or not, infants are motivated to learn about the world around them from various models in various contexts, as long as there is no rational or obvious reason for a preference of specific informants or contexts.

3.1.3 Discussion of Study Set 1

The primary aim of Study Set 1 was to test the local-expertise hypothesis (Stenberg, 2009). By varying both informants and locations, we expected 14-month-old infants to selectively receive and use information from the informant associated with the location in which the study took place. If infants' looked more consistently at the experimenters in previous laboratory studies with the expectation that certain individuals possess knowledge or expertise in certain locations, as suggested by Stenberg (2009), we expected that infants would demonstrate a similar expectation toward their parent when tested in their homes. However, we did not find any evidence for the local-expertise hypothesis, neither in Study 1a nor in Study 1b.

One could argue that a possible reason for our observed lack of evidence for the local-expertise hypothesis might mainly be due to a lack of an association between the experimenter and the laboratory. Compared to the extensive association between the infants' parents and their homes, participants did not have much experience with the experimenter as the expert in the laboratory. However, as in previous studies which investigated the local-expertise hypothesis,

we made sure that the experimenter expressed his expertise in the laboratory by showing the parents how to get to the laboratory (e.g., he opened the doors, he showed the family where to sit, he offered and provided the beverages, and so on, see Stenberg, 2009). All these indicators of expertise were reversed at the infants' homes and observable for participants in both locations (that is, when visiting the home, it was the parents who opened the doors, showed the experimenters were to sit, offered the experimenters beverages, etc.). Nonetheless, infants' referencing behaviors were not in line with simple parent-context associations. Rather, in Study 1a and Study 1b we did find that the informant has a significant main effect: When providing information, infants looked at the experimenter for a longer amount of time than at the parent, regardless of the location and emotional valence.

Infants' Looking Behavior in the Exploration and Imitation Task

This looking preference for the experimenter is consistent with what has been found in previous studies (Stenberg, 2003, 2009; Stenberg & Hagekull, 2007; Walden & Kim, 2005), however, those studies only took place in the laboratory. The current findings demonstrate that infants' heightened social referencing toward the experimenter is a robust phenomenon, found in locations other than the laboratory. Moreover, infants showed more joint engagement with the experimenter than the parent, indicating that they did not only look longer at the experimenter than at the parent, but also related the information to the objects and action more when the experimenter presented the box or modeled an action than when the parent did so. Thus, even in the home location, for which one might expect the person-context association to be extraordinarily strong, infants did not look at their parents for a longer amount of time when s/he provided information about the novel box and modeled a novel action.

Infants' preference for the experimenter in their looking behavior across locations is consistent with different interpretations. It may be that infants considered the experimenter to be the better source of information about the objects. One could argue that this consideration is due to infants' and children's preference of informants who appear certain and confident (Birch, Akmal, & Frampton, 2010; Matsui, Yamamoto, & McCagg, 2006; Moore, Bryant, & Furrow, 1989; Poulin-Dubois et al., 2011; Sabbagh & Baldwin, 2001). For a more detailed discussion about this see the General Discussion in this dissertation (section 4.3.1). Another possibility why infants might have considered the experimenter as a more reliable source of information could be due to the fact that the boxes, tool sets and actions were novel and therefore may be more associated with the experimenter, who was also novel in both locations. Infants' longer looking was not simply characterized by prolonged fixation on the experimenter himself, but by alternating their gaze between the source and the box he presented and action he modeled.

Given evidence that infants are capable of representing certain ownership relations (Blake & Harris, 2009; Blake & Harris, 2011; Fasig, 2000; Hay, 2006), it is possible that the novelty of the boxes, tool sets and actions across locations supported their interest in acquiring information from the novel experimenter who seemed familiar with them. If this interpretation is correct, it provides support for a reformulated version of Stenberg's local-expertise hypothesis. That is, infants' selective appeal to experimenters may not be explained by associations they form between certain individuals and laboratory locations, but between certain individuals and the objects they present ('object expertise') or actions they model ('action expertise'), and appear familiar with, and discuss. This appearance of the experimenter as being familiar with the novel objects or actions, in turn, might refer to infants' perception of the experimenter as being more certain and confident in this experimental situation as opposed to the infants' parents.

Second, one might wonder whether infants' increased looking at the experimenter in both studies was caused simply by the fact that the unfamiliar informant was novel to participants. This novelty alone may have elicited more attention to the unfamiliar informant, since novelty does attract infants' attention (Fantz, 1964; Rose & Tamis-LeMonda, 1999). There is support in Study 1a for this novelty explanation. First, some support comes from infants' looking behavior during the neutral trial. In the neutral trial, although no one provided any information about the novel box, infants still looked longer at the experimenter than at the parent. However, this looking difference might still reflect infants' preferential search for information from the experimenter, who might be expected to provide information about the box in this trial. Second, further support for the novelty explanation might come from the fact that infants' selective appeal to the experimenter did neither extend to their exploratory behavior on the boxes themselves, nor to the imitative behavior when copying the modeled action. If infants privileged information from the experimenter about the objects and actions, one would expect them to actually *use* this information during their exploration of the boxes and imitation of the actions. That is, if infants privileged information provided by the experimenter, then one might expect greater box exploration when the experimenter displayed positive emotions than when he displayed negative emotions, and one could expect the increased use of the experimenter tool rather than the parent tool when imitating the action. However, infants' exploration of the boxes was not related to the valence of the experimenter's emotional expressions, and, similarly, infants did not imitate the experimenter. Thus, infants' looking preferences for the experimenter were not mirrored in their exploration of the boxes and imitation of the modeled actions, which suggests that infants' predominant looking at the experimenter during the presentation and demonstration phase may have been caused simply by their interest in an unfamiliar informant.

However, for a broader discussion about this issue see the General Discussion in the current dissertation (section 4.3.1).

Infants' Exploratory and Imitative Behavior

The effect of the informant on infants' exploratory behavior contrasts with her/his effect on infants' looking patterns. Infants explored the boxes more when the parent presented them than when the experimenter presented them, regardless of the emotions displayed and the location at which the experiment took place. This result also arose when analyzing infants' exploratory behavior when the informants presented the box as opposed to the neutral trial. While infants explored the boxes more when the parent presented them compared to the exploration rate in the neutral trial, no such effect occurred for the comparison of trials in which the experimenter presented the boxes and the neutral trial. This finding suggests similarity to the results of a study that manipulated an informant's novelty in a social referencing task by either playing with infants prior to the experiment for approximately 15 minutes (less-novel experimenter) or not playing with infants prior to the experiment at all (novel experimenter). In the subsequent social referencing task, infants played more with the toy after receiving information from the less-novel experimenter than from the novel experimenter (Stenberg, 2012). However, in this study, no familiar informant was present. Thus, the effect in our study may rather reflect 14-month-olds' more general trust in their parents, resulting in a more efficient or rapid referencing of the parent due to the cumulative experience with this person (i.e., "familiarity effect", Walden & Kim, 2005, p. 360; Corriveau et al., 2009). In line with this finding, Corriveau and Harris (2009) found that 3-year-olds (as well as 4- and 5-year-olds) searched for and used information more when provided by a familiar rather than unfamiliar teacher. When the authors contrasted familiarity with inaccuracy, the youngest children (3 years of age) still trusted the more familiar informant despite her past inaccuracy. Thus, a ready reliance on information provided by trusted, familiar informants may be present in infancy and early childhood (Bowlby, 1969; Corriveau et al., 2009; Zarbatany & Lamb, 1985).

In accordance with this assumption, the model effect in the first trial of Study 1b might express a spontaneous trust in parents' demonstrations. One might argue that the participants' preference for the parent tool in the first trial was caused by their feeling of aversion against the unfamiliar model due to his novelty (see "the fear of strangers", Bowlby, 1969, p. 323; Ainsworth, 1967; Morgan & Ricciuti, 1969; Tennes & Lampl, 1964). However, two arguments contradict this explanation. First, all participants took part in a warm-up phase prior to the experiment. In this phase, infants observed the experimenter (who later was the unfamiliar model) interacting with infants' parents for approximately ten minutes. Thus, infants' aversion

and negative expectations – if there were any – likely decreased within this phase. Second, we can assume that participants did not refuse to imitate the unfamiliar model in the first trial simply because they were distracted by or afraid of this person given the significant body of research from different laboratories demonstrating spontaneous learning from unfamiliar experimenters in 14-month-olds (Buttelmann et al., 2008; Carpenter, Akhtar et al., 1998; Gergely et al., 2002; Meltzoff, 1988; Poulin-Dubois et al., 2011). Instead, it seems that when given the choice between a familiar and an unfamiliar model, 14-month-olds prefer to learn from the familiar one.

Although infants at this young age are already highly selective in their social learning even when presented with repeated instances to learn (Brugger, Lariviere, Mumme, & Bushnell, 2007; Buttelmann et al., 2008; Buttelmann et al., 2013; Carpenter, Akhtar et al., 1998; Gergely et al., 2002; Ryalls et al., 2000; Zmyj et al., 2010; Zmyj et al., 2012), they seem to imitate the modeled actions from familiar and unfamiliar adults in both familiar and unfamiliar locations at a similar level across all trials. In order to understand this result, it might be helpful to take a look at the situations in which selective imitation is a rational (i.e. efficient) strategy. It is a rational strategy, for instance, when the characteristics of a model, of the objects involved, or of the location in which the demonstration takes place, are relevant aspects that might lead to different levels of effective or efficient social learning. For example, a model who demonstrated her/his competence in the past might be considered more trustworthy than a model who demonstrated incompetence (Zmyj et al., 2010), suggesting that learning from the competent model seems more efficient. From this perspective, our finding that the participants in the current study did not differ between both models overall is not surprising, since both models did not differ in their levels of reliability; for example, they both successfully elicited identical effects although using different tools. Thus, there seemed to be no rational reason for preferring one tool over the other. Similarly, although infants in Study 1a preferred to explore the object presented by the familiar informant, they did not respond differently to differing emotions from either of the two informants. This equal use of others' information might also refer to the infants' assumption that the informants did not differ in terms of their knowledge about the novel boxes. Both informants induced the impression of being knowledgeable concerning the object's evaluation because both provided infants with emotional information.

Accordingly, both informants did not directly differ in terms of their knowledge about the novel objects and actions and therefore participants had to infer their knowledge states based on the informants' association with the location of the experiment. One can imagine that the inferential steps necessary to ascribe different knowledge states to the informants were too

sophisticated for infants at this age. They had to ascribe an informant's local expertise based on the association with the location in a first inferential step (i.e. the informant who is associated with the location has knowledge about this location), and they had to ascribe knowledge about the presented objects and modeled actions based on the informants' local expertise in a second inferential step (i.e. the informant who has knowledge about the location has knowledge about the objects/actions in the location). The combination of these inferential steps might have been too sophisticated and therefore led to a comparable ascription of knowledge resulting in the comparable information use between the familiar and unfamiliar informants across all trials in both studies.

Control Analyses

Finally, we would like to discuss the possible influence of the fact that the gender between the familiar informant and the unfamiliar informant differed for most of the participants (i.e., for most infants the informants consisted of their mothers and the male experimenter). One might argue that we might have found different results when testing all participants with their fathers or by having a female experimenter. However, we did not find any differences in our control analyses in terms of infants' imitative behavior in Study 1b and also no differences for the most important measurements of infants' social referencing behavior in Study 1a between same-gendered (i.e. father as familiar informant) and different-gendered (i.e. mother as familiar informants) informants. Thus, the gender difference between the informants present for most of the participants cannot explain our results.

Conclusion

In conclusion, our studies contribute important empirical evidence to the research field of infants' selective social learning. Neither of the two studies support the local-expertise hypothesis in 14-month-olds when presented with both an unfamiliar and familiar informant in an unfamiliar and familiar location. However, infants in both studies received more information from the unfamiliar informant than from the familiar informant. In contrast, infants explored the objects more when presented by the familiar than the unfamiliar informant, regardless of the displayed emotions (Study 1a), and infants spontaneously preferred to imitate the familiar than unfamiliar informant but imitated both informants to an equal amount across all trials (Study 1b) across locations. Consequently, both infants' information reception and use decidedly challenges the local-expertise hypothesis in terms of unfamiliar and familiar locations and informants.

3.2 Study Set 2: Infants' Selectivity due to Informants' Knowledge States Based on Visual Perspective

As indicated by the results of Study Set 1, the hypothesis that infants receive and use information provided by the informant who is associated with a certain location could not be supported, neither for information concerning the valence of a novel object (Study 1a), nor for information concerning a modeled action (Study 1b). A detailed look at this hypothesis and, with it, the design of the two studies, clarifies that the informants' knowledge about the novel object or the modeled action did not directly differ between the familiar and unfamiliar informant. Thus, the results of Study Set 1 can only provide limited evidence of infants' ability to select knowledgeable informants as reliable sources of information and therefore it still remains an open question in developmental psychology sciences whether infants in their second year of life are already able to select knowledgeable informants. This ability seems to be of special importance since others' knowledge about a certain object or action determines the quality of the provided information. To differentiate between a more or less knowledgeable informant and, therefore, to prefer the knowledgeable informant, enables a better and more efficient selection of informants and, as a result, the relevant information to solve a problem. In order to affect infants' selective social learning behavior in their second year of life, it seems to be necessary to manipulate an informant's knowledge state more directly. To investigate this, we designed Study Set 2, in which two informants obviously differed in terms of their knowledge about the location of an object in a hiding-finding game.

In the two different longitudinal studies of this study set, we investigated whether infants at 14 months of age and infants at 19 and 20 months of age follow the indications of an informant who saw how an object was hidden in one out of two boxes (knowledgeable informant) more often than the indications given by an informant who did not see in which box it was hidden (ignorant informant). We made use of a hiding-finding game as a research paradigm, since it reflects an interesting social learning situation for infants and 14-month-olds usually already know and like this game. Based on the empirical evidence of infants' understanding about others' visual perspective and theory of mind, we hypothesize that participants of both studies use more information from the knowledgeable rather than from the ignorant informant. For an overview of the manipulated variables (i.e. highlighted in green), the mediums and entities, as well as the infants' age, of Study Set 2, see Figure 12.

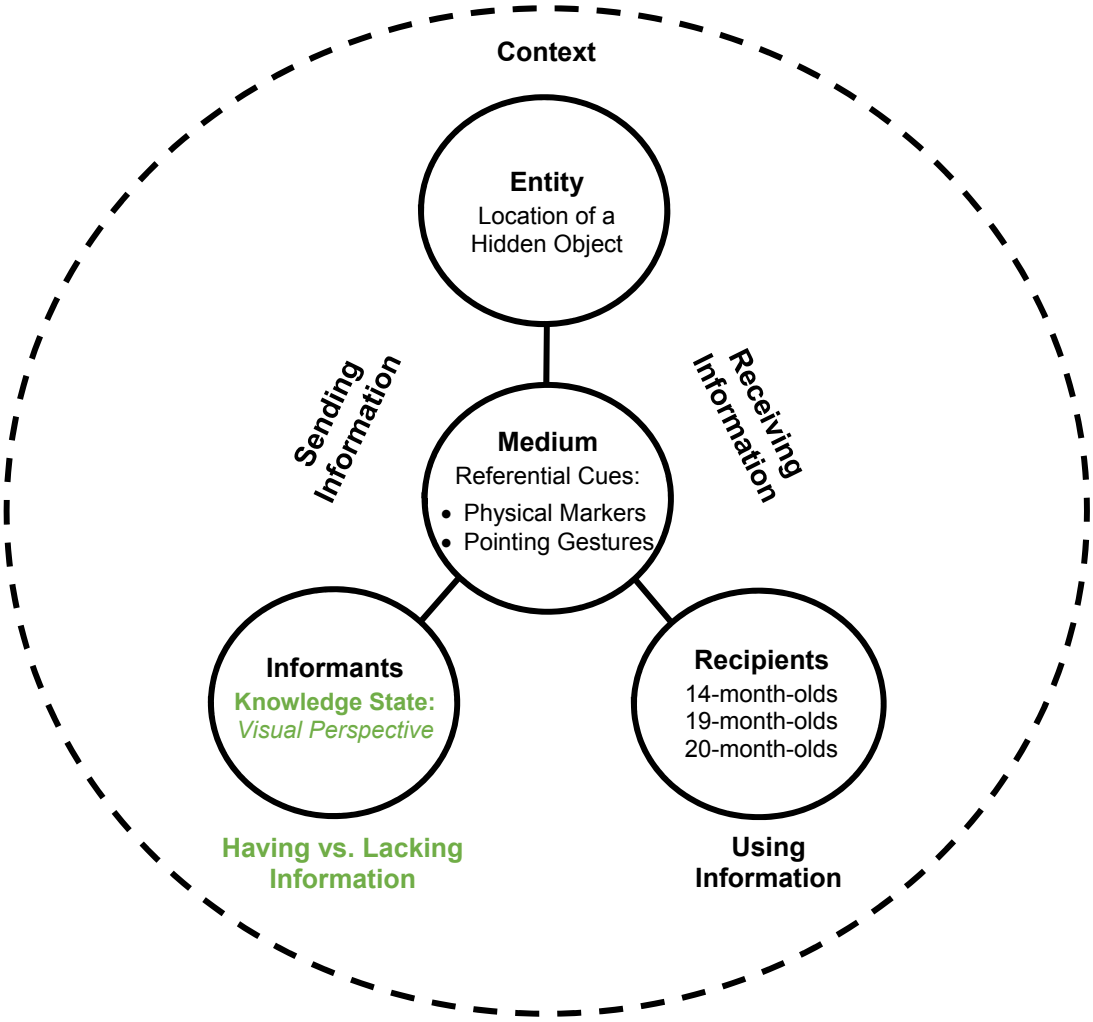

Figure 12. Overview of Study Set 2 based on the Organon model.

3.2.1 Study 2a: Varying Informants' Visual Perspective in a Hiding-Finding Game I

In the first study, we investigated whether 14- and 19-month-old infants used a physical marker in combination with a brief non-static pointing gesture as a referential cue (warm-up phases), and whether they selectively preferred information provided by a knowledgeable informant over that of an ignorant informant (object-choice test). Subsequently, we investigated whether infants implicitly held the expectation that the knowledgeable informant would always indicate the correct location (i.e., the box that contained the toy) by presenting them with consistent outcomes (i.e., the toy is in the box indicated by the knowledgeable informant) and inconsistent outcomes (i.e., the toy is in the box not indicated by the knowledgeable informant) and by measuring the time infants looked at the outcomes (looking-time test). In this study, we used a physical marker as predictor to consistently highlight the target box. However, although there are studies showing that 2.5- and 3-year-old children (Moore et al., 2013; Tomasello et

al., 1997) and domestic dogs (e.g., Agnetta, Hare, & Tomasello, 2000; Riedel, Buttelmann, Call, & Tomasello, 2006) make use of physical markers as referential cues to find a hidden reward, nothing is known about infants' use of such more abstract referential cues as reference to a certain entity or location in their environment. Given the lack of empirical evidence for the effect of abstract referential cues, as a first step, we combined the marker cue with a brief non-static pointing gesture, a gesture infants around their first year of life make use of, as shown in previous studies (see section 1.1.2). For an overview of the manipulated (i.e. highlighted in green) and measured components of Study 2a based on the Organon model, see Figure 13.

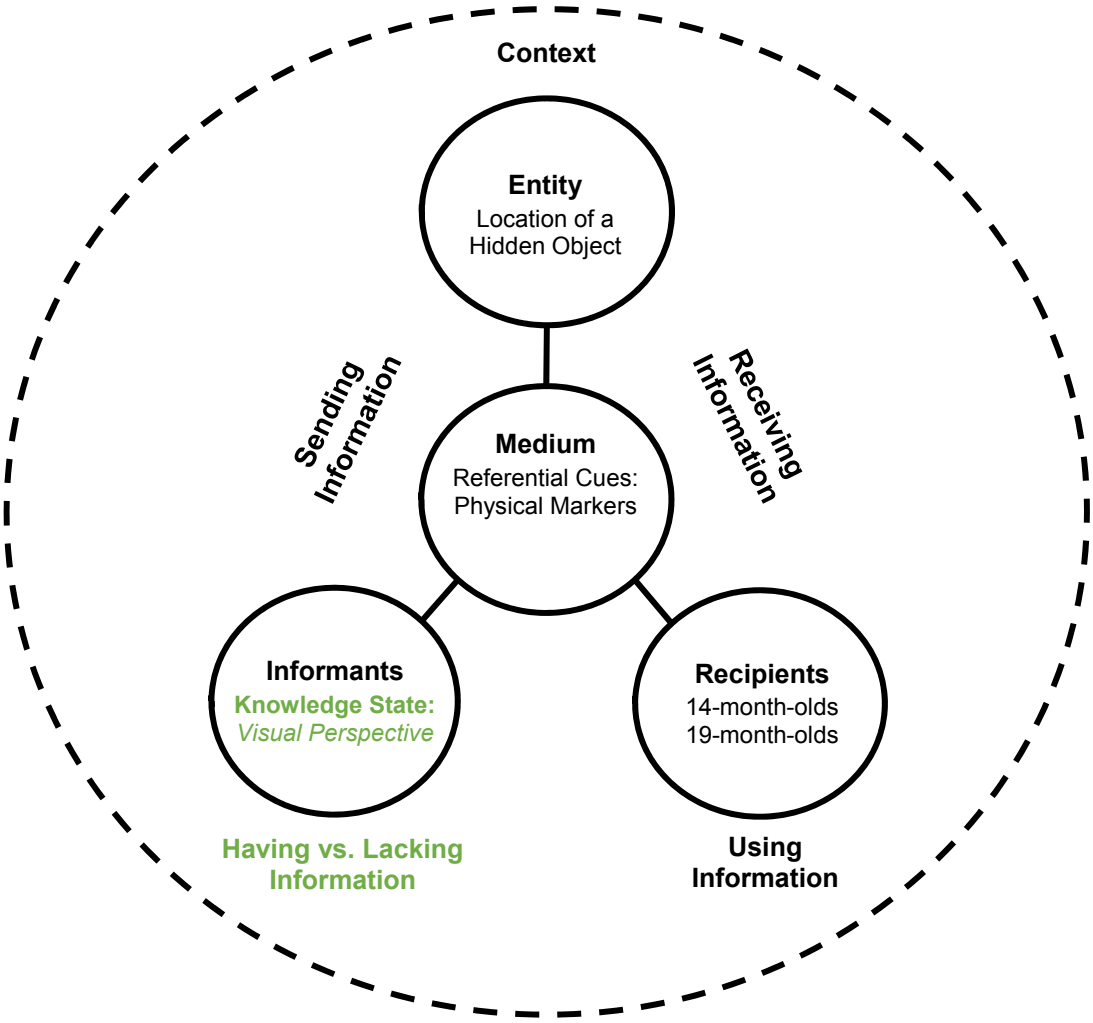

Figure 13. Overview of Study 2a based on the Organon model.

Method

Participants

The sample consisted of 40 infants at an age of 14 months (mean age = 14 months; 0 days, age range = 12;29 to 15;4, 19 females, 21 males). Moreover, we re-invited all participants

approximately 5 months after the first session and were able to test 30 infants again (mean age = 18 months; 25 days, age range = 17;3 to 20;0, 13 females, 17 males). One additional 19-month-old infant was tested but excluded from the data analyses due to fussiness. Participants were recruited from a database of parents who had agreed to participate in child development studies in a mid-sized German city. In addition to their general agreement, parents signed a consent form for participating in the current study prior to testing. Each infant received a certificate and a toy after their participation.

Apparatus and stimuli

Testing took place in a theatre-like set-up, in which the infant sat on the parent's lap at one side of a table. The other three sides had big frames with curtains that could be closed and opened. The experimenter sat at the same table, opposite to the infant. During the warm-up phase, both informants were outside of the testing room, and did not enter the test room before the test phase. One camera was placed behind the infant to record an overview of the experimental set up and everybody's actions. A second camera was placed opposite the infant in order to record the infant's gazing behavior and hand movements towards the boxes. In each trial, the experimenter hid an object (a little toy that made a noise when being squeezed, approximately 5 x 5 x 6 cm) in one of two wooden boxes (20 x 15 x 15 cm). Four different toys were used in the warm-up phases, another four different toys were used in the test phases (see Figure 14).

Figure 14. Study 2a: Hiding toys. The four toys in the upper row were used in the warm-up phases, the four toys in the lower row were used in the object-choice and the looking-time test.

As physical markers we used wooden blocks (8 x 3 x 6 cm). In order to facilitate infants' association between the experimenter/informants and the experimenter's/informants' markers, we first equipped the markers with pictures of the experimenter and the informants and, second, we colored the markers and had the experimenter/informants wear T-shirts in the conforming

color (experimenter: red, warm-up phases; informants: yellow and green, test phases, see Figure 15). By this, we kept demands on participants' memory capacities as low as possible. The inside of both boxes was covered with soft cloth to avoid noise when hiding the toys in the boxes. A little table stood below the testing table on the experimenter's side and served as a storage for the eight toys, as well as the stop watch and the order sheet.

Figure 15. Study 2a: Physical markers. The markers used in the hiding-finding game: a) the red marker was placed by the experimenter in the warm-up phases, b) the green marker was placed by the green informant in the test phases, and c) the yellow marker was placed by the yellow informant in the test phases.

Procedure

After the participants arrived, the female experimenter asked the parent to fill out a consent form and played with the infant. While doing so she explained the procedure to the parent without telling any hypotheses or aims of the study. In this phase, both informants – the green- and the yellow-clothed – were present in the play room, sitting on a sofa (both informants were male). They did not interact with the infant. However, infants could watch the informants and get familiar with their special outfits. Moreover, in this play phase the experimenter presented the three markers to the infant (see Figure 5), and then handed over the informants their markers in order to build up a first association between the informants and their color-matched markers. After this, both informants left the play room and waited in a separate room until the test phase of the experiment started. Then, the experimenter, the infant and the parent went into the testing room and the experiment started with the warm-up phases.

Warm-Up phases. Infants received eight trials in which the experimenter hid the toy in one of the two wooden boxes. Within the first four trials (warm-up phase 1), this hiding action happened in full sight of the infants, that is, they saw in which box the experimenter hid the toy. At the beginning of each trial the experimenter held the toy up with both hands, centered between both boxes, and said "Look what I have here!"[7] She then elicited a sound from the toy

[7] Original German wording: "Schau mal was ich hier habe!"

by squeezing it and said "Listen!"[8] while she squeezed the toy once more. Before the experimenter put the toy in one of the two boxes she said "Pay attention!"[9], laid the toy down between both boxes, opened both boxes simultaneously, and put the toy in one box while saying "I put it in here!"[10] Then she shifted her gaze between the infant and the toy in the box while saying "Look!"[11] The experimenter then took the marker in the hand opposite to the box containing the toy (i.e., the target box), pointed at the target box with the index finger of the hand holding the marker, looked at the box and said "It is in here!"[12] Then, she looked at the infant again, said "Look!"[13] while shaking the red marker in her hand. She then looked back at the target box and said "Here it is!"[14] while placing the marker on a small platform directly behind the target box (see Figure 3 for the end position of the marker behind the target box). While indicating the correct location of the toy the experimenter displayed positive and engaging facial expressions. This was done since an adult's positive, engaging facial expression and the presence of her/his hand facilitates 2- and particularly 3-year-olds' ability to identify the correct referent of a hidden object when presented with abstract cues (Leekam, Solomon, & Teoh, 2010). Finally, the experimenter closed both boxes simultaneously, asked the participants "Where is the thing? Search in one box!"[15] and moved the boxes into the infants' reach. Participants were allowed to search for the toy. If infants did not make a choice the experimenter repeated her question and requested the infant to search for it every 10 seconds. In case infants still did not open the indicated box within 60 seconds, the experimenter opened the target box to give infants the experience that the toy was indeed inside the box the experimenter indicated. Regardless of infants' choice, the experimenter handed infants the toy to play with for approximately 30 seconds in order to keep them motivated and to avoid reward based learning effects. Afterwards, the experimenter took the toy from the child, pulled back the boxes, and the next trial started. The procedure of the second four trials of the warm-up phase (warm-up phase 2) was similar, except that from this phase on infants could not observe the hiding action anymore since the experimenter blocked their view with an occluder while hiding the toy. For an illustration of both warm-up phase 1 and warm-up phase 2, see Figure 16.

[8] Original German wording: "Hör' mal!"
[9] Original German wording: "Pass auf!"
[10] Original German wording: "Hier leg' ich es rein!"
[11] Original German wording: "Schau!"
[12] Original German wording: "Es ist hier drin!"
[13] Original German wording: "Schau!"
[14] Original German wording: "Hier ist es drin!"
[15] Original German wording: "Wo ist das Ding? Such mal in einer Box!"

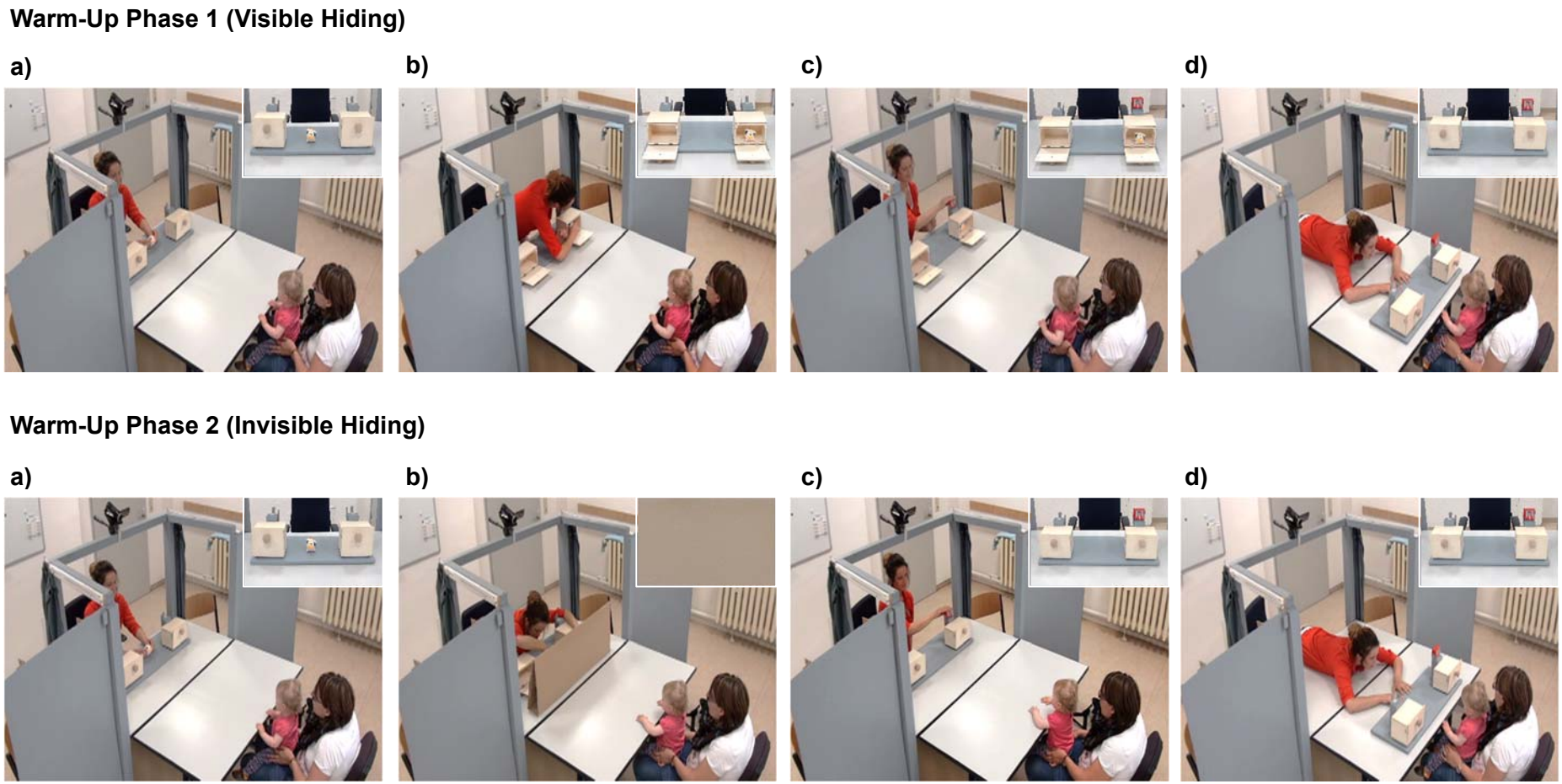

Figure 16. Study 2a: Procedure of the warm-up phases. The figure shows the hiding procedure of both warm-up phase 1 (visible hiding) and warm-up phase 2 (invisible hiding). In each warm-up phase, the experimenter a) presented the object, b) hid the object in one box (visible for infants in warm-up phase 1; covered by an occluder and therefore invisible for infants in warm-up phase 2), c) indicated the hidden object's location by placing the red marker on the box, and d) moved the boxes into the infant's reach in order to enable the infant's object search. Each picture contains another little picture in the upper right edge displaying the infant's view of the boxes.

Test phases. At the beginning of the test phases the experimenter called the informants in the testing room. In the *object-choice test*, participants received another four trials in which the experimenter hid the toy invisible to infants. For this test, the experimenter used a new set of squeezing toys, which were presented as in the warm-up phases. Before the experimenter hid the toy in one of the two boxes she said "Pay attention!"[16] and placed the occluder on the table in between the infant and the boxes. While the experimenter hid the toy, one informant stood up and observed the hiding (knowledgeable informant) and the other informant stood up and looked at the ceiling, away from the hiding (ignorant informant, see Figure 6). Then the experimenter said "I put it in here!"[17] which was commended with "Aha" by the knowledgeable informant and with "Mhm" by the ignorant informant. Subsequently, the experimenter took away the occluder and the first informant (counterbalanced) indicated a box by holding the marker in one hand, pointing at the box with the index finger of that hand, looking at it and saying "It is in here"[18]. Then, he looked at the infant, said "Look!"[19] while shaking his marker in his hand. He then looked back at the target box and said "Here it is"[20] while placing his marker on the platform behind the target box. Then the other informant indicated the other box by performing in the identical manner as the first informant (see Figure 3 for the end positions of the markers behind the boxes). Finally, after both informants had placed their markers, the experimenter said to the participants "Where is the thing? Search in one box!"[21] and moved the boxes into the infants' reach. Participants were then allowed to search for the toy. Note, in the test phase both boxes were locked, thus, participants did not get any feedback in which box the toy was actually hidden. This was done to avoid that infants learned about which of the two informants was reliable und used this information in later trials. If infants did not tried to open a box the experimenter repeated her question and told the infant to search for it. As soon as infants tried to open a box or after the maximum response time of 60 seconds elapsed the experimenter pulled back the boxes, and the next trial started. The sitting position of the informants was counterbalanced between participants to control for side preferences.

The *looking-time test*, which directly followed the object-choice test, consisted of eight test trials. The procedure of this test phase was identical to that of object-choice test except that infants were not allowed to search for the toy. Instead, the experimenter closed the curtains at

[16] Original German wording: "Pass auf!"
[17] Original German wording: "Hier leg' ich es rein!"
[18] Original German wording: "Es ist hier drin!"
[19] Original German wording: "Schau!"
[20] Original German wording: "Hier ist es drin!"
[21] Original German wording: "Wo ist das Ding? Such mal in einer Box!"

both sides of the apparatus in order to cover both informants, asked "Where is the thing?"[22], opened both boxes simultaneously, kept her hands at the boxes, faced downwards, and waited for 20 seconds. During this time we measured infants' looking time at the scene. Four of the eight test trials in the looking-time test were presented in a congruent condition in which the knowledgeable informant indicated the box with toy, and the other four trials were presented in an incongruent condition in which the knowledgeable informant indicated the empty box. By comparing infants' looking time at the scene in the two conditions, we could investigate their expectations about which informant should indicate the box with toy. If infants had the expectation that the knowledgeable informant always indicated the box with toy (because he knew where it was hidden), we expected them to show longer looking times in the incongruent compared to the congruent condition. These longer looking times would reveal that the outcome of the trial violated infants' expectations (see Gergely, Nádasdy, Csibra, & Bíró, 1995; Koechlin, 1997; Onishi & Baillargeon, 2005 for uses of this measurement in different areas of developmental cognitive psychology). The two conditions (consistent/inconsistent) were alternating presented in two-trial blocks with the order of blocks counterbalanced between participants. The test phases were presented in this order (object-choice test first, looking-time test second) because otherwise the looking-time test might have influenced the object-choice test. That is, infants could have experienced in the first one that the knowledgeable informant was not a reliable source of information, and might refuse following his cues in the object-choice test. For an illustration of both the object-choice and the looking-time test, see Figure 17.

The whole procedure was identical at both appointments. After finishing looking-time test, the informants, the experimenter, the parent, and the infant went back to the play room, where the experimenter explained the hypotheses and aims of the study to the parent (only after the second appointment). The experiment lasted approximately 25 minutes. The whole session was videotaped.

[22] Original German wording: "Wo ist das Ding?"

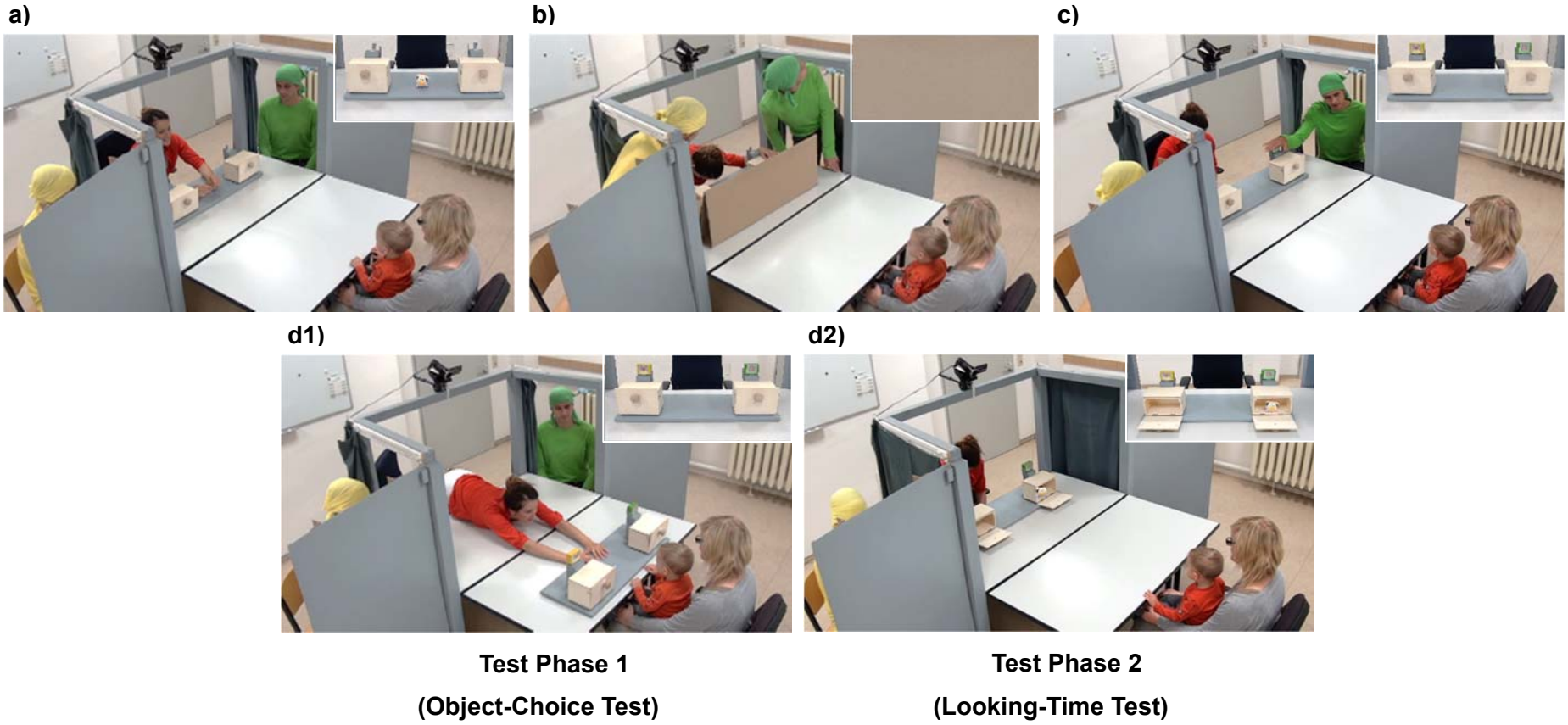

Figure 17. Study 2a: Procedure of the test phases. The figure shows the hiding procedure of both test phase 1 (object-choice test) and test phase 2 (looking-time test). In each test phase, the experimenter a) presented the object and b) hid the object in one box (invisible for infants), which was observed by the knowledgeable informant (in this example the yellow clothed informant) and not observed by the ignorant informant who explicitly looked away (in this example the green clothed informant). Following to the hiding, c) both informants provided conflicting indications about the hidden object's location by placing, one after another, their markers on different boxes. In the object-choice test, d1) the experimenter moved the boxes into the infant's reach to measure the infant's object-choice behavior. In the following looking-time test, d2) the experimenter opened both boxes to reveal the object's location, while the infant's looking time was measured. Each picture contains another little picture in the upper right edge displaying the infant's view of the boxes.

Coding and Analyses

Warm-up phases. In this phase, we measured infants' use of the experimenter's referential cues indicating the location of the hidden toy. For this, we coded infants' first looks at a box as well as their grasping responses (i.e., first touch of a box, first attempt to open a box, first box opened) from the moment the experimenter's asked the question "Where is the thing?" until the trial stopped. For participants' first look at a box we coded '1' if infants looked first at the indicated box (target box), and '0' if infants looked first at the box which was not indicated by the experimenter (empty box). Moreover, as a first touch of a box we coded which box infants touched with their hands first ('1' = target box; '0' = empty box). If infants tried to open the box by pulling the flap with their hands we coded this as the first attempt to open a box ('1' = target box; '0' = empty box). Finally, we coded which box infants successfully opened first by opening the flap of a box with their hands ('1' = target box; '0' = empty box).

Test phases. In order to measure whether infants' looking behavior revealed an understanding of the informants' referential cues we coded infants' first look at a box and their active choice of a box the same way coding was done for the warm-up phases. However, if participants looked first at the box indicated by the ignorant informant it was coded '0', and if infants looked first at the box indicated by the knowledgeable informant it was coded '1'. The coding of infants' choices of a box was coded following this scheme. However, we did not code which box infants opened first in the object-choice test because the boxes were locked and infants could not open them.

In the looking-time test, we measured infants' looking time (in seconds) at the boxes, at the scene (i.e., the experimenter and the apparatus), and overall (i.e., a sum score of infants' looking at the boxes and their looking at the scene) within the 20 seconds after the experimenter opened the boxes. For a trial to count as valid infants had to look at the area of interest for at least 2 seconds. Measuring ended as soon as infants looked away for at least 2 seconds. We adopted this participant-based coding from previous studies using the violation of expectation paradigm (e.g., Onishi & Baillargeon, 2005).

Data reliability

In order to assess inter-rater reliability for the dependent variables, a naive research assistant, who was blind to the aims and hypotheses of the study, coded half of the sample. The Intraclass-Correlation (ICC) for the inter-rater reliability for the 14-month-old sample was at least .98, $p < .001$, for all variables in the warm-up phases; it was at least .99, $p < .001$, for all variables in the object-choice test; and it was at least .86, $p < .001$, for infants' looking time in the looking-

time test. ICC for the 19-month-old sample was at least .99, $p < .001$, for all variables in the warm-up phases; it was at least .98, $p < .001$, for all variables in the object-choice test; and it was at least .83, $p < .001$, for infants' looking time in the looking-time test. Moreover, in order to guarantee that all trials were of identical presentation quality we excluded those trials in which the experimenter (warm-up phases, 14-month-olds: 3 out of 320 trials; 19-month-olds: 2 out of 240 trials), or the informants (test phases, 14-month-olds: 11 out of 480 trials; 19-month-olds: 7 out of 360 trials) did not provide their suggestions of the hidden toy as it was intended (e.g., deviation from the speech protocol, or incorrect pointing gesture or placing of the marker). Moreover, we also excluded those trials (14-month-olds: 9 out of 320 trials; 19-month-olds: 6 out of 240 trials) from the analyses of the looking-time test for which there occurred any disruptions (e.g., verbal comments or other cues that could have influenced infants' looking behavior). The reliability for the coding of presentation quality was done also for the half of the sample. It resulted in high correlations for the warm-up phases and the test phases for both ages (14 months: all ICCs ≥ .96, $p < .001$; 19 months: all ICCs ≥ .89, $p < .001$).

Results

14-month-olds

Warm-up phases. We conducted Wilcoxon tests to investigate infants' performance in the first warm-up phase. In this phase, infants looked first at the indicated box (M = 73.3% of trials, SD = 26.4) more often than would be expected by chance (50% of trials), Wilcoxon test, Z = -4.162, $p < .001$, r = 0.47. They showed a similar preference in their grasping response. That is, infants touched the indicated box first (M = 74.8% of trials, SD = 25.3) more often than chance level, Z = -4.394, $p < .001$, r = 0.49; they first attempted to open the indicated box (M = 76.7% of trials, SD = 24.3) more than chance level, Z = -4.584, $p < .001$, r = 0.52; and they also opened the indicated box first (M = 73.5% of trials, SD = 25.1) more often than expected by chance level, Z = -4.061, $p < .001$, r = 0.47.

In the second warm-up phase, infants looked at the indicated box first (M = 60.2% of trials, SD = 23.6) more often than would be expected by chance, Z = -2.571, p = .010, r = 0.29. Regarding their choice of a box we found the following results: Infants' first touches of the indicated box (M = 54.5% of trials, SD = 20.1) and their attempts to open the indicated box first (M = 53.6% of trials, SD = 19.5) did not differ from chance level, Z = -1.429, p = .153, r = 0.16, and Z = -1.432, p = .152, r = 0.16, respectively. However, they first opened the indicated box (M = 56.5% of trials, SD = 19.3) more often than would be expected by chance, Z = -2.223, p = .026, r = 0.26.

Test phase 1. We conducted Wilcoxon tests to investigate infants' performance in the object-choice test. In this test phase, infants did not show any preference for any of the informants (knowledgeable or ignorant) for none of the variables: first look at a box, Wilcoxon test, $Z = -0.254$, $p = .799$, $r = 0.03$; first touch of a box, $Z = -0.090$, $p = .928$, $r = 0.01$; first attempt to open a box, $Z = -0.207$, $p = .836$, $r = 0.03$. For descriptives see Table 7.

This same pattern of results was found when we analyzed the first trial only: first look at the box indicated by the knowledgeable informant (n = 18 participants) versus the ignorant informant (n = 21 participants), Binominal test, $N = 39$, $p = .749$; first touch of the box indicated by the knowledgeable informant (n = 15 participants) versus the ignorant informant (n = 20 participants), Binominal test, $N = 35$, $p = .500$; first attempt to open the box indicated by the knowledgeable informant (n = 14 participants) versus the ignorant informant (n = 19 participants), Binominal test, $N = 33$, $p = .487$.

Test phase 2. We conducted Wilcoxon tests to investigate infants' performance in the looking-time test. In this test phase, infants did not differ in their looking times between conditions in any of the variables: looking at the boxes (congruent condition: $M = 6.1$ seconds, $SD = 2.9$; incongruent condition: $M = 6.1$ seconds, $SD = 2.6$), Wilcoxon test, $Z = -0.139$, $p = .889$, $r = 0.02$, looking at the scene (congruent condition: $M = 5.9$ seconds, $SD = 2.9$; incongruent condition: $M = 6.5$ seconds, $SD = 2.9$), $Z = -0.699$, $p = .484$, $r = 0.08$, and overall looking (congruent condition: $M = 12.1$ seconds, $SD = 4.6$; incongruent condition: $M = 12.6$ seconds, $SD = 3.7$), $Z = 0.000$, $p = 1.000$, $r = 0.00$. The analyses of only the first trial resulted in the same pattern: looking at the boxes (congruent condition: $M = 5.4$ seconds, $SD = 3.6$; incongruent condition: $M = 6.0$ seconds, $SD = 3.4$), $Z = -0.844$, $p = .399$, $r = 0.10$, looking at the scene (congruent condition: $M = 8.3$ seconds, $SD = 4.4$; incongruent condition: $M = 8.7$ seconds, $SD = 4.7$), $Z = -0.344$, $p = .731$, $r = 0.04$, and overall looking (congruent condition: $M = 13.7$ seconds, $SD = 5.9$; incongruent condition: $M = 14.7$ seconds, $SD = 5.4$), $Z = -0.369$, $p = .712$, $r = 0.04$.

19-month-olds

Warm-up phases. To investigate infants' performance in the first warm-up phase, we conducted Wilcoxon tests. In this phase, infants looked first at the indicated box ($M = 83.3\%$ of trials, $SD = 20.1$) and touched the indicated box first ($M = 80.6\%$ of trials, $SD = 25.3$) more often than expected by chance, Wilcoxon test, $Z = -4.463$, $p < .001$, $r = 0.58$, and $Z = -4.041$, $p < .001$, $r = 0.52$, respectively. Furthermore, infants attempted to open the indicated box first ($M = 83.1\%$ of trials, $SD = 25.0$) and opened the indicated box first ($M = 82.2\%$ of trials, $SD =$

27.3) more than chance level, $Z = -4.193$, $p < .001$, $r = 0.54$, and $Z = -4.106$, $p < .001$, $r = 0.53$, respectively.

In the second warm-up phase, infants looked at the indicated box first ($M = 64.2\%$ of trials, $SD = 29.9$) significantly above chance level, $Z = -2.310$, $p = .021$, $r = 0.30$. Further, infants touched the indicated box first ($M = 68.3\%$ of trials, $SD = 23.1$), attempted to open the indicated box first ($M = 69.2\%$ of trials, $SD = 24.3$) , and opened the indicated box first ($M = 70.0\%$ of trials, $SD = 24.0$) more than expected by chance, $Z = -3.427$, $p < .001$, $r = 0.44$; $Z = -3.276$, $p < .001$, $r = 0.42$; and $Z = -3.385$, $p < .001$, $r = 0.44$, respectively.

Test phase 1. To investigate infants' performance in the object-choice test, we conducted Wilcoxon tests. In this test phase, infants did not show any preference for any of the informants (knowledgeable or ignorant) for none of the variables: first look at a box, $Z = -0.230$, $p = .818$, $r = 0.03$; first touch of a box, $Z = -1.275$, $p = .202$, $r = 0.17$; first attempt to open a box, $Z = -1.494$, $p = .135$, $r = 0.20$. For descriptive statistics see Table 7.

Table 7. *Study 2a: Descriptive statistics of the warm-up phases and the object-choice test. Mean percentages and standard deviations (in italics) of trials in which infants first looked at, first touched, first attempted to open, and first opened the box indicated by the experimenter (warm-up 1 and 2) or the knowledgeable informant (object-choice test) for both infants at 14 and 19 months of age.*

	14-month-olds			**19-month-olds**		
	Warm-Up 1	**Warm-Up 2**	**Object-Choice test**	**Warm-Up 1**	**Warm-Up 2**	**Object-Choice test**
First Look	73.3***	60.2**	50.6	83.3***	64.2*	50.8
	26.4	*23.6*	*16.9*	*20.1*	*29.9*	*22.2*
First Touch	74.8***	54.5	49.8	80.6***	68.3***	55.0
	25.3	*20.1*	*17.6*	*25.3*	*23.1*	*24.0*
First Attempt	76.7***	53.6	50.7	83.1***	69.2***	55.6
	24.3	*19.5*	*20.1*	*25.0*	*24.3*	*24.3*
First Open	73.5***	56.5*	-	82.2***	70.0***	-
	25.1	*19.3*		*27.3*	*24.0*	

Note. Differences against chance performance: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$.

The same pattern of results was found when we analyzed the first trial only: first look at the box indicated by the knowledgeable informant (n = 14 participants) versus the ignorant informant (n = 15 participants), Binominal test, N = 29, p = 1.0; first touch of the box indicated by the knowledgeable informant (n = 14 participants) versus the ignorant informant (n = 11 participants), Binominal test, N = 25, p = .690; first attempt to open the box indicated by the knowledgeable informant (n = 13 participants) versus the ignorant informant (n = 10 participants), Binominal test, N = 23, p = .678.

Test phase 2. The analyses in the looking-time test were based on Wilcoxon tests. In this test phase, like at the age of 14 months, infants did not differ in their looking times between conditions in any of the variables: looking at the boxes (congruent condition: M = 5.9 seconds, SD = 2.5; incongruent condition: M = 5.5 seconds, SD = 2.4), Z = -1.219, p = .223, r = 0.16, looking at the scene (congruent condition: M = 7.8 seconds, SD = 2.6; incongruent condition: M = 8.4 seconds, SD = 2.6), Z = -1.219, p = .223, r = 0.16, and overall looking (congruent condition: M = 13.7 seconds, SD = 3.7; incongruent condition: M = 13.9 seconds, SD = 3.3), Z = -0.443, p = .657, r = 0.06. The analyses of only the first trial resulted in the same pattern: looking at the boxes (congruent condition: M = 5.7 seconds, SD = 2.5; incongruent condition: M = 5.7 seconds, SD = 3.0), Z = -0.279, p = .780, r = 0.04, looking at the scene (congruent condition: M = 10.8 seconds, SD = 3.7; incongruent condition: M = 11.4 seconds, SD = 3.6), Z = -0.421, p = .674, r = 0.06, and overall looking (congruent condition: M = 16.5 seconds, SD = 4.3; incongruent condition: M = 17.1 seconds, SD = 2.8), Z = -0.216, p = .829, r = 0.03.

Differences between infants' responses at 14 and 19 months of age

Warm-up phases. To investigate longitudinal differences in the warm-up phases between infants' performance in their first and second participation, we conducted Wilcoxon tests. In the first warm-up phase, there were no differences between the two appointments for the variables that measured infants' grasping response, that is, when infants' first touched, first attempted to open and first opened a box (all ps ≥ .299). However, infants marginally significantly directed their first look more at the indicated box (M = 83.3% of trials, SD = 20.1) at the age of 19 months than they did at the age of 14 months (M = 71.9% of trials, SD = 26.4), Z = -1.941, p = .052, r = 0.25.

In the second warm-up phase, infants first touched (M = 68.3% of trials, SD = 23.1 versus M = 52.5% of trials, SD = 21.6), Z = -2.966, p = .003, r = 0.38, first attempted to open (M = 69.2% of trials, SD = 24.3 versus M = 52.8% of trials, SD = 20.8), Z = -2.968, p = .003, r = 0.38, and first opened (M = 70.0% of trials, SD = 24.0 versus M = 56.3% of trials, SD = 20.4),

$Z = -2.475$, $p = .013$, $r = 0.32$, the indicated box more at the age of 19 months than at the age of 14 months. There was no difference regarding their first look at the indicated box ($M = 64.2\%$ of trials, $SD = 29.9$ versus $M = 62.8\%$ of trials, $SD = 18.9$), $Z = -0.100$, $p = .920$, $r = 0.01$.

Test phase 1. Wilcoxon tests were conducted in order to compare infants' performance in the object-choice test between the first and second appointment. In this test phase, infants at the age of 19 months marginally significantly touched ($M = 55.0\%$ of trials, $SD = 24.0$), $Z = -1.884$, $p = .060$, $r = 0.25$, and attempted to open ($M = 55.6\%$ of trials, $SD = 24.3$), $Z = -1.776$, $p = .076$, $r = 0.24$, the box that was indicated by the knowledgeable informant first more than did infants at the age of 14 months (first touch: $M = 46.5\%$ of trials, $SD = 20.3$; first attempt: $M = 47.6\%$ of trials, $SD = 19.0$). There was no difference in infants' preference to look at the box indicated by the knowledgeable informant first ($M = 50.8\%$ of trials, $SD = 22.2$ versus $M = 50.8\%$ of trials, $SD = 20.1$), $Z = -0.263$, $p = .793$, $r = 0.03$, or in any of the measures for only the first trial (Wilcoxon tests, all ps $\geq .348$). For a bar chart of infants' performance in the warm-up phases and the object-choice test for both 14- and 19-month-olds, see Figure 18.

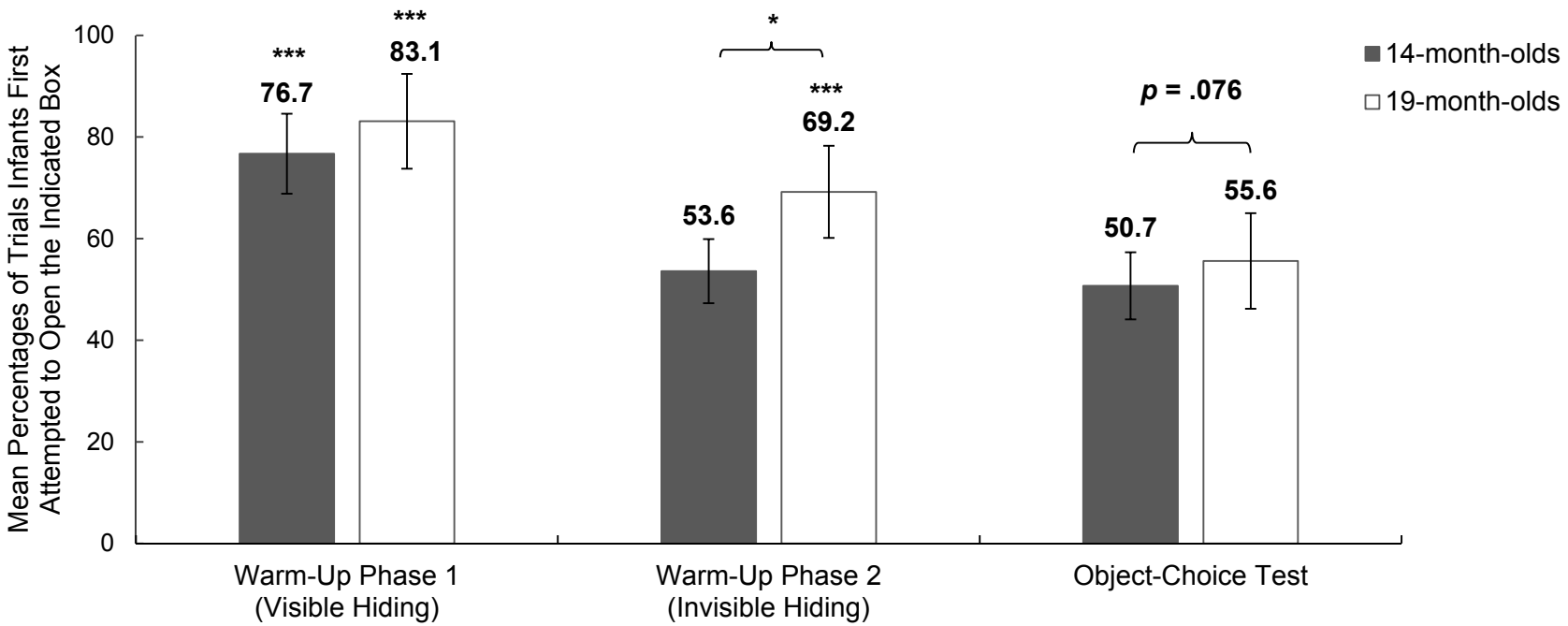

Figure 18. Study 2a: Bar chart of infants' grasping behavior. The graph shows the mean percentages of trials infants at 14 and 19 months of age first attempted to open the box indicated by the experimenter (warm-up phases) and the knowledgeable informant (object-choice test). Significances are highlighted with asterisks based on Wilcoxon tests comparing infants' behavior with chance performance as well as between their first participation at 14 months of age and their second participation at 19 months of age. Note: $^{*}p \leq .05$, $^{***}p \leq .001$. Error bars show 95% confidence intervals.

Test phase 2. In the looking-time test, there were no differences in infants' looking times at incongruent compared to congruent scenes between 14 months and 19 months of age (Wilcoxon tests, all *p*s ≥ .559) overall, as well as for only the first trial (Wilcoxon tests, all *p*s ≥ .432).

Correlations between infants' responses at 14 and 19 months of age

When investigating whether there was a correlation between infants' use of the experimenter's referential cues in the second warm-up phase at 14 months of age and a preference for following the referential cues given by the knowledgeable informant in the object-choice test at 19 months of age, no such relation was found for none of the single variables (Spearman correlations for all dependent variables, all r_ss(28) ≤ -.201, all *p*s ≥ .305). Moreover, infants' performance in the object-choice test at the age of 14 months did not correlate with their performance at the age of 19 months (Spearman correlations for all dependent variables, all r_ss(26) ≤ .204, all *p*s ≥ .318).

Control Analyses

There were no effects of infants' gender, neither for when participants were 14 months of age (Mann-Whitney *U* tests, warm-up phases: all *p*s ≥ .536, all *r*s ≤ .12; object-choice test: all *p*s ≥ .432, all *r*s ≤ .16; looking-time test: all *p*s ≥ .474, all *r*s ≤ .15), nor for when they were 19 months of age (Mann-Whitney *U* tests, warm-up phases: all *p*s ≥ .145, all *r*s ≤ .30; object-choice test: all *p*s ≥ .134, all *r*s ≤ .31; looking-time test: all *p*s ≥ .374, all *r*s ≤ .17). When checking for effects of informants (green versus yellow) in the object-choice test for infants at the age of 14 months, there were no effects on their first touch and first attempt to open a box (Mann-Whitney *U* tests, both *p*s ≥ .321, all *r*s ≤ .11). However, 14-month-olds preferred to look first at the box indicated by the yellow clothed informant (*M* = 56.5% of trials, *SD* = 15.6) compared to the box indicated by the green clothed informant (*M* = 43.5% of trials, *SD* = 15.6), Wilcoxon test, *Z* = -2.288, *p* = .022, *r* = 0.26. No such effects were found for the 19-month-olds (Wilcoxon test, all *ps* ≥ .146, all *rs* ≤ .19). Furthermore, infants did not have any side preferences toward the right or left box, neither at 14 months of age (Wilcoxon tests, all *p*s ≥ .100, all *r*s ≤ .26), nor at 19 months of age (Wilcoxon tests, all *p*s ≥ .237, all *r*s ≤ .23). Finally, we analyzed whether the order of the informants in the object-choice test (the knowledgeable informant's indication first versus the ignorant informant's indication first) influenced infant's object-search behavior. No such influence was found, neither for 14-month-olds (Mann-Whitney *U* tests, all *p*s ≥ .290, all *r*s ≤ .15), nor for 19-month-olds (Mann-Whitney *U* tests, all *p*s ≥ .525, all *r*s ≤ .09).

Discussion

The aim of this study was twofold: We wanted to investigate whether infants could use an abstract referential cue to infer a hidden object's location and whether they took the informants' knowledge states into account when doing so. For this, we presented 14- and 19-month-olds with a hiding-finding game in which an experimenter (warm-up phases) or two informants (test phases) placed physical markers (in combination with a pointing gesture) on opaque boxes in order to indicate an object's location. In the test phases, the informants differed in their knowledge states: One informant knew where the object was hidden (knowledgeable informant) and the other was ignorant about this. First, our results suggest that infants at 14 months of age do not use the physical marker as an indicator for the object's location in all the variables, even though this referential cue also included a (non-static) pointing gesture. However, infants do use such an abstract referential cue in various measurements at the age of 19 months, as our sample demonstrated when tested again about 5 months later. These results provide evidence for a noticeable development of this ability from 14 to 19 months: 19-month-olds significantly improved in their use of physical markers in combination with a non-static pointing gesture as a referential cue compared to the use of this cue at 14 months of age. This is a crucial step in the developmental pathway of infants' ability to use abstract referential cues which leads to 2.5- and 3-year-olds making use of physical markers, even when presented without the accompanying non-static pointing gesture (Tomasello et al., 1997), and 3-year-olds use of light and sound as referential cues (Moore et al., 2013).

Our second research question focused on infants' use of the informants' knowledge states. In contrast to our expectations, infants did not show a preference for a knowledgeable over an ignorant informant, neither at 14 nor at 19 months of age. Moreover, the analysis of younger and older infants' looking behavior did not provide any evidence for infants holding the expectation that the knowledgeable informant would indicate the correct location of the object. However, when we directly compared both age groups' performance in the object-choice test, we found some evidence for an improvement of this ability with participants' age. Infants at 19 months of age tended to follow the indications of the knowledgeable versus the ignorant informant more than they did at 14 months of age. Thus, the ability to recognize an informant's knowledge state and to take this into account in a hiding-finding game seems to slightly develop within the second year of life. Yet, this conclusion has to be drawn carefully, since infants at 19 months of age did not use the knowledgeable informant's indications more than they used the ignorant informant's indications.

The control analyses revealed that 14-month-olds preferred to look at the box with the yellow marker first. This preference could be due to the color of the marker or the picture of the yellow-clothed informant on the marker. However, this was not a strong preference since it only affected infants' first look at a box but not their active choice of a box. It seems unlikely that this preference reflects infants' perception of the yellow-clothed informant as the more reliable informant in this hiding-finding game since this looking preference did not affect infants' decision-making when deciding which box to search; and we know from previous research that informants' reliability does have an effect on infants' subsequent actions (Koenig & Sabbagh, 2013; Zmyj et al., 2010; see Harris & Lane, 2013, for a review).

One might wonder whether the method used in this study might be responsible for participants' failure to demonstrate their ability to make use of the informants' knowledge states. For example, the use of the physical marker in combination with the non-static pointing gesture was a prerequisite for a successful application of this ability. A look at the results of the second warm-up phase reveals that infants at 14 months (first attempted to open the indicated box at chance level, 53.6% of trials) as well as at 19 months of age (first attempted to open the indicated box above chance level, however, still not even in three out of four trials, 69.2% of trials) had difficulties to reliably use this abstract referential cue as an indicator for the hidden object. Consequently, these low levels of successful use of the referential cue might be the reason why participants were not selective in their use of the informants' indications. Moreover, the attention and memory demands of the task were relatively high: Participants had to track the visual perspective of two informants at the same time and to remember them until they themselves chose a box. This might have been too challenging for participants at this age. Finally, another possible reason why infants did not show selectivity between the informants might be the use of the occluder when blocking infants' view during the hiding action. This required participants to imagine what might happen behind the occluder while it blocked infants' visual perspective (i.e., infants had to understand that what the knowledgeable informant observed was the hiding process). Due to infants' limited cognitive resources they might have had difficulty relating the subsequent actions with what had gone on before (see Behne et al., 2005 for a similar explanation). In order to find out whether any of these possibilities might explain the findings of Study 2a, we modified and improved the current paradigm and ran Study 2b.

3.2.2 Study 2b: Varying Informants' Visual Perspective in a Hiding-Finding Game II

The aim of this second longitudinal study was similar to that of Study 2a. That is, we wanted to investigate whether infants evaluated the reliability of an informant based on her/his knowledge state. However, since infants within their second year of life seem to have difficulty with abstract referential cues, we modified the paradigm used in Study 2a. Instead of using the physical markers, we used a constant pointing gesture, a referential cue that young infants have repeatedly shown they are able to use from around their first birthdays (Aureli et al., 2009; Behne et al., 2005; Behne et al., 2012; Bretherton, 1991; Carpenter, Nagell et al., 1998; Desrochers et al., 1995; Murphy & Messer, 1977; Tomasello, 1999; Tomasello & Akhtar, 1995; Woodward & Guajardo, 2002). Moreover, by applying a between-subjects design, we presented only one informant and manipulated her/his knowledge state in order to reduce the cognitive demands of the task and to facilitate infants' focus on the informants' visual perspective during the hiding action. Thereby, we also eliminated possible confusion caused by two conflicting indications at the same time (see procedure Study 2a). Finally, we did not use the occluder to cover the hiding action but rather used smaller toys that the experimenter could hide within her/his hands, invisible to infants (see also Behne et al., 2005). Given these improvements and infants' success in previous studies on knowledge and belief understanding (Buttelmann et al., 2009; Buttelmann et al., 2015; Kovács et al., 2010; Poulin-Dubois et al., 2013), we assumed that infants would be able to use the constant pointing gesture as a referential cue and to selectively follow the indications of the knowledgeable informant. For an overview of the manipulated (i.e. highlighted in green) and measured components of Study 2b based on the Organon model, see Figure 19.

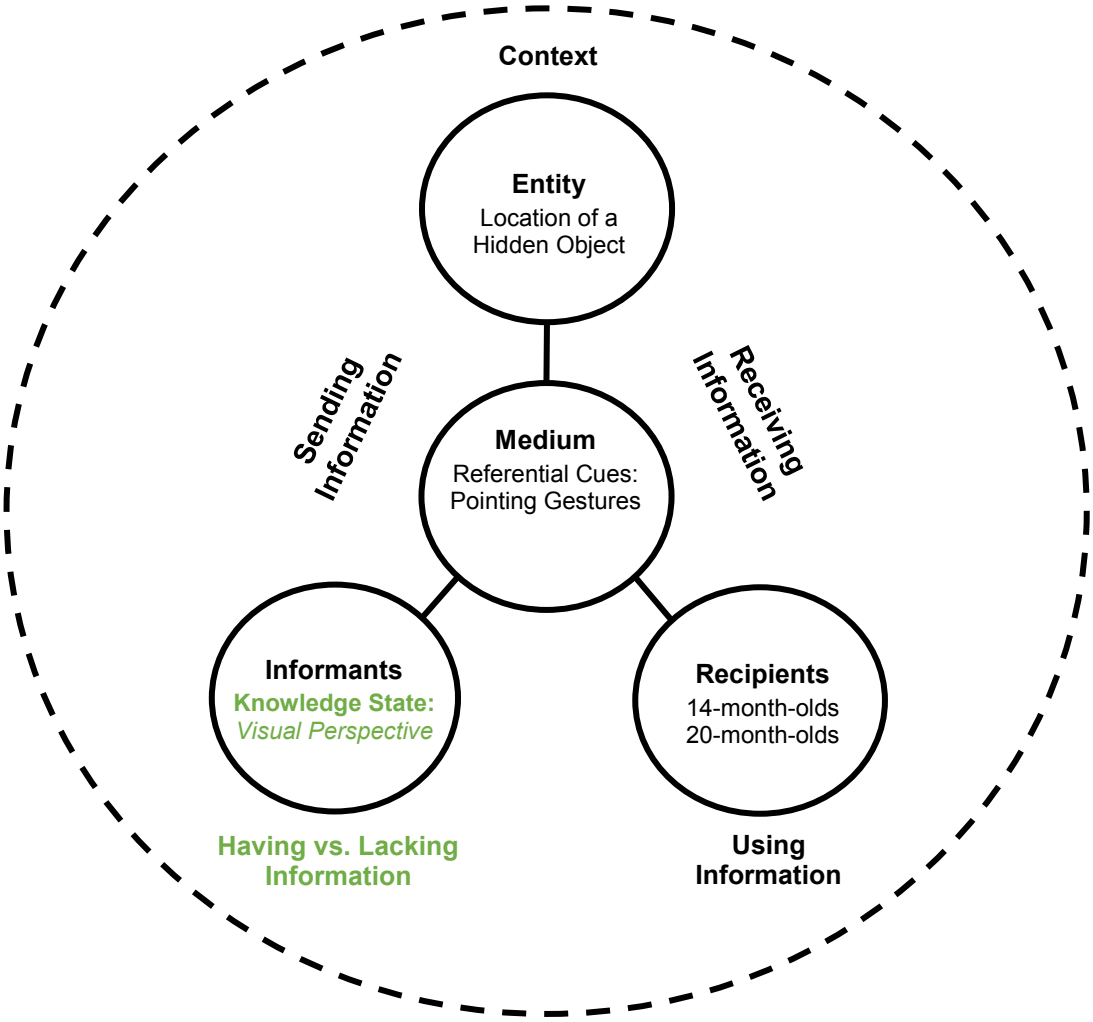

Figure 19. Overview of Study 2b based on the Organon model.

Method

Participants

The sample consisted of 99 14-month-olds (mean age = 13 months; 27 days, age range = 12;30 to 15;6, 49 females, 50 males). An additional infant was tested but excluded from the analyses due to fussiness. Moreover, we re-invited those infants approximately 6 months later and were able to re-test 77 of them (mean age = 20 months; 1 day, age range = 18;12 to 23;7, 36 females, 41 males). Like in Study 2a, infants were recruited from a database of parents who had agreed to participate in child development studies in a mid-sized German city. In addition to their general agreement, parents signed another consent form for participating in the current study prior to testing. Each infant received a toy and a certificate after their participation in this study.

Apparatus and stimuli

For this study, infants sat at a table in a high chair. The informant sat opposite to the infant at the same table. In the warm-up phases, the experimenter and the parent sat at the left and the right side of the infant slightly behind her/him, whereas in the test phase the experimenter took the seat of the informant to hide the toys and the informant sat next to the experimenter to observe or ignore the hiding, depending on condition, and to indicate a box (see procedure below). One camera was placed opposite the infant in order to record the infant's gazing behavior and hand movements toward the boxes. A second camera was placed behind the infant to record the overview of the experimental set up. In each trial, the informant (warm-up phases) or the experimenter (test phase) hid an object (i.e., a little colored toy with wobble eyes, 3.5 cm wide and deep, and 5 cm high, see Figure 20) in one of two grey boxes (15 cm diameter, and 8 cm high, see Figure 21). The lids of the boxes differed in their color (i.e., grey or white) for each trial in order to decrease perseveration errors (Behne et al., 2012). The ground of both boxes was equipped with soft cloth to ensure a silent drop of the toys when hiding them in the boxes. Moreover, there was a little cardboard container (also provided with soft cloth) fixed below the table at the informant's side where the toys were placed during the test phase (see procedure below). A little table below the testing table served as a storage for the eight toys and the order sheets.

Figure 20. Study 2b: Hiding toys. The toys used as hiding objects in the warm-up phases (upper row) and in the test phase (lower row).

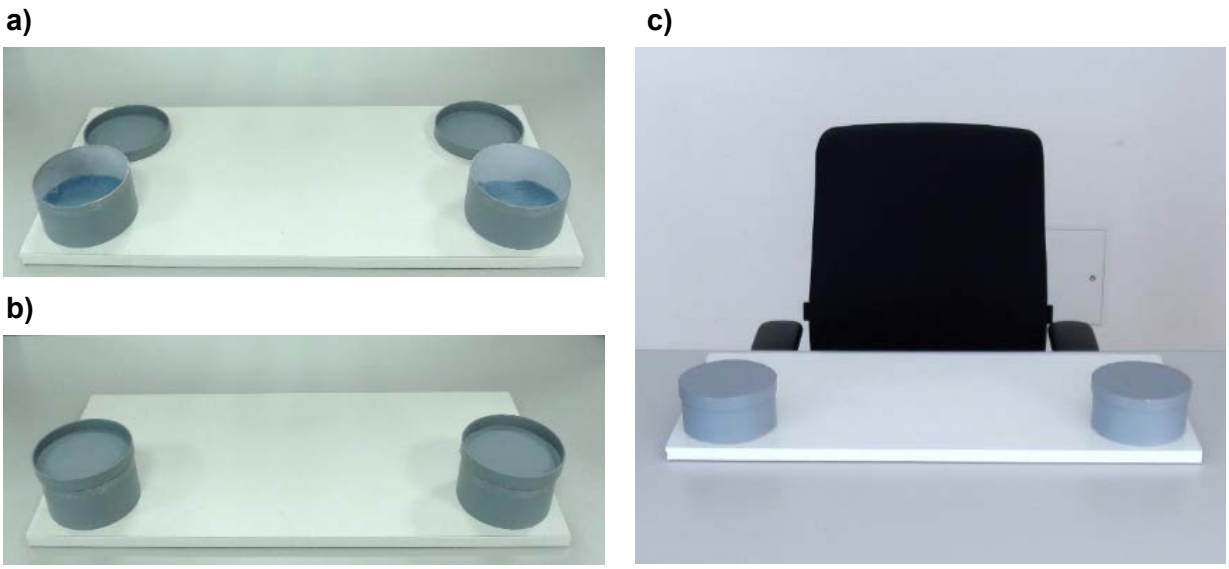

Figure 21. Study 2b: Hiding boxes. The boxes used in the hiding-finding game were fixed on a white tray. The boxes were a) open before each hiding action, b) slightly covered in the warm-up phases, and c) closed in the test phase.

Procedure

After arrival the parent filled out a consent form. The informant played with the infant and informed the parents about the procedure without mentioning any hypotheses of the study. Then the informant, the parent and the child entered the testing room, where the informant asked half of the parents to play with their infants on a carpet with a selection of toys for five minutes (the other half of the parents were asked to do so after the experiment). These free play sessions were included for another study not reported here (see Study 4c, section 3.4.3). This manipulation did not affect the results of the current study, since there were no differences in performance in the current study between infants who had played with their parents prior and those who played after the experiment (all *p*s ≥ .288). Note, the informant in this study was either female or male, depending on the gender of infants' parents, which served as an important methodological manipulation of Study 3 (see section 3.3). We checked for possible effects of the informants' gender differences on infants' performance in the current study (see *Control Analyses*).

Warm-Up phases. The procedure of the warm-up phases was similar to those in Study 2a, except for the following modifications: At the beginning of each trial the informant held the toy between her/his hands and tapped with the toy between both boxes while s/he said "Look what I have here!"[23] Then the informant said "Look!"[24] and repeated the tapping. Before the

[23] Original German wording: "Schau mal was ich hier habe!"
[24] Original German wording: "Sieh' mal!"

informant hid the toy in one of the two boxes s/he said "Pay attention!"[25], then s/he moved the toy below the table with both hands, put the toy in one hand, and moved both hands up so that each hand was directly above a box – the left hand above the left box and the right hand above the right box. The informant then moved both hands simultaneously into the boxes – the left hand into the left box and the right hand into the right box –, and opened both hands while s/he put the toy in the box and said "I put it in here!"[26] When s/he took out her/his hands, the informant striped the both boxes with her/his backhands to ensure that there was the same sound from both boxes when hiding the toy. Afterwards, the informant covered both boxes simultaneously by putting the lids onto the boxes. In these phases, the lids were put on the boxes upside down to make it easier for participants to open the boxes (see Figure 21). Then, the informant indicated the box in which s/he hid the toy by pointing at the target box, looking at it and saying "It is here inside!"[27] After this, s/he looked again at the infant and then back to the target box while saying "Here it is!"[28] and moved the index finger back and forth toward the box. Finally, the informant asked the participants "Where is the thing?"[29] and moved the boxes into the infants' reach with her/his hand, while still pointing at the target box with the other hand. Participants could now search for the toy. If infants did not make a choice the informant repeated her/his question and asked the infants to search for it every 10 seconds. In case infants still did not touch a box within 60 seconds or opened only the empty box, the informant opened the target box and showed them the toy inside to give them the experience that the informant indicated the correct box. Like in Study 2a, infants got the toy as reward irrespective of whether they found it themselves or not. After approximately 30 seconds, the informant took the toy back and started the next trial. The difference between the first warm-up phase (trials 1 to 4) and the second warm-up phase (trials 5 to 8) was that infants could see the toy in the informant's hand in warm-up phase 1 but were unable to see it in warm-up phase 2 because the informant hid it within her/his hand. For an illustration of both warm-up phase 1 and warm-up phase 2, see Figure 22.

[25] Original German wording: "Pass auf!"
[26] Original German wording: "Hier leg' ich es rein!"
[27] Original German wording: "Es ist hier drin!"
[28] Original German wording: "Hier ist es drin!"
[29] Original German wording: "Wo ist das Ding?"

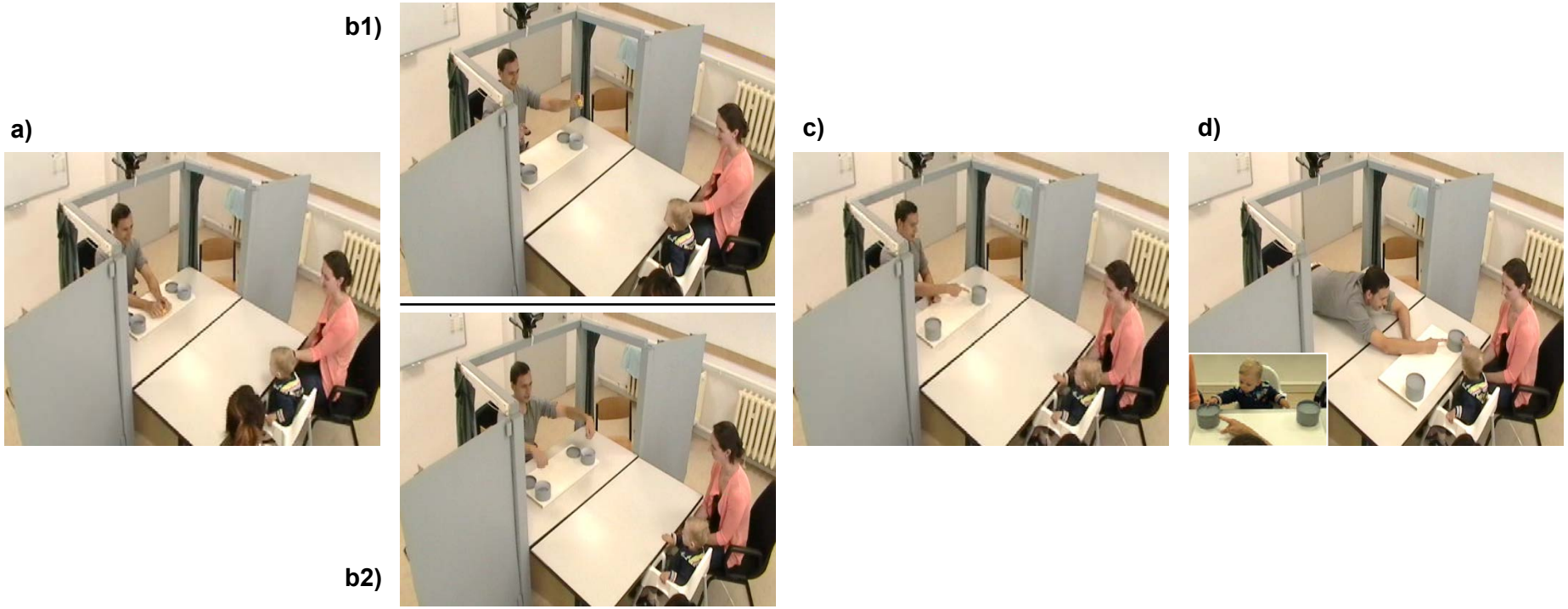

Figure 22. Study 2b: Hiding procedure of the warm-up phases. The figure shows the hiding procedure of both warm-up phase 1 (visible hiding) and warm-up phase 2 (invisible hiding). In each warm-up phase, the informant a) presented the object, b) hid the object in one box b1) visible for infants in warm-up phase 1 and b2) with the object covered in the informant's hands and therefore invisible for infants in warm-up phase 2, c) indicated the hidden object's location by pointing at the box, and d) moved the boxes into the infant's reach in order to enable the infant's object search. Picture d) contains another little picture in the lower left edge displaying the measured object-choice behavior of the infant.

After the eight warm-up trials, infants received a first test phase that consisted of four trials and is not the focus of this study. After this phase, the informant gave infants two more trials in the style of warm-up phase 1 and let infants search for the hidden toy in order to motivate them. This was necessary since they would not be able to open the boxes in the subsequent object-choice test.

Test phase. For the *object-choice test* the experimenter took the seat of the informant and the informant sat next to the experimenter. The object-choice test consisted of four trials, in which the experimenter hid the toys while the informant either looked away (ignorant informant) or paid attention to the hiding action (knowledgeable informant), according to condition that varied between subjects (see Figure 23). The experimenter used a new set of toys (see Figure 21) which were different to the toys in the warm-up phases to exclude infants' inferences based on associations between certain toys and their hide in the warm-up phases. Like in the warm-up phases, the experimenter held the toy between her/his hands and tapped with the toy between both boxes while saying "Look what I have here!"[30] Then the experimenter said "Look!"[31] and repeated the tapping. Following this, and unlike the warm-up phases, the experimenter now only pretended to hide the toy. This was done since in the test phase participants did not receive any feedback about in which box the toy was hidden. The lack of feedback about the toy's location was important since infants should not draw any inferences about the informant's reliability. Before the experimenter pretended to hide the toy in one of the two boxes s/he said "Pay attention!"[32], which was at the same time the signal for the informant to take her/his position according to condition: In order to remain *ignorant* s/he turned around and looked away, in order to become *knowledgeable* or s/he moved forward and looked into the boxes to explicitly observe the hiding action. The experimenter then moved the toy below the table with both hands, put the toy into the little cardboard container (invisible to infants), and, identically to the warm-up phases, moved both hands up so that each hand was directly above a box. The experimenter then moved both hands simultaneously into the boxes, and opened both hands while s/he pretended to put the toy in a box and said "I put it in here!"[33]. This comment functioned as another sign for the informant who moved her/his head and said "Aha!" (knowledgeable) or "Mhm!" (ignorant) to direct infants' attention to her/his visual perspective. The experimenter then striped the both boxes with her/his backhands to ensure that there was the same sound from both boxes when hiding the toy. Then, the experimenter closed

[30] Original German wording: "Schau mal was ich hier habe!"
[31] Original German wording: "Sieh' mal!"
[32] Original German wording: "Pass auf!"
[33] Original German wording: "Hier leg' ich es rein!"

both boxes simultaneously by putting the lids on the boxes. In this phase, infants were not able to open the boxes because the lids were fixed on the boxes (see Figure 6). After the experimenter hid the toy s/he said "So!" as a signal for the informant to provide her/his information about the location of the hidden toy. For this, the experimenter moved aside, and the informant indicated one box in exactly the way s/he had done in the warm-up phases. That is, the informant pointed at the target box, looked at it and said "It is here inside!"[34] Then, s/he looked at the infant again and back at the target box while saying "Here it is!"[35] The informant maintained her/his pointing gesture, asked the infant "Where is the thing?"[36] and moved the boxes into the infants' reach. If infants did not make a choice the informant repeated her/his question and asked the infants to search for it every 10 seconds. The informant pulled the boxes back as soon as infants tried to open a box or after the 60 seconds of response time were over. Then the next trial started. For an illustration of the test phase, see Figure 23. After the experiment, the experimenter, the informant, the parent, and the infant went back to the play area where the experimenter explained the hypotheses and ideas of the study to the parent (after the second appointment). The experiment lasted approximately 25 minutes. The whole session was videotaped.

[34] Original German wording: "Es ist hier drin!"
[35] Original German wording: "Hier ist es drin!"
[36] Original German wording: "Wo ist das Ding?"

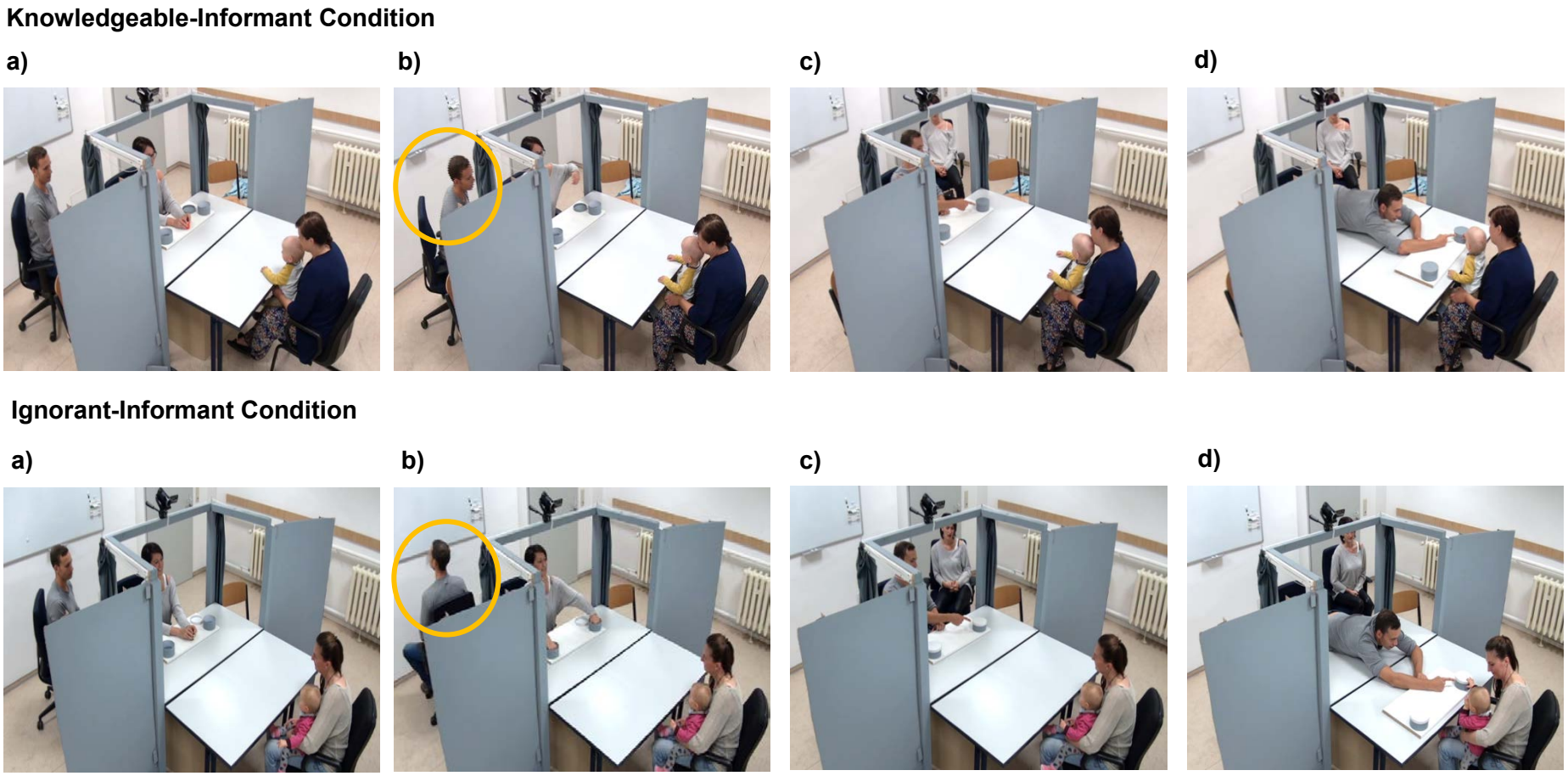

Figure 23. Study 2b: Hiding procedure of the test phase. The figure shows the hiding procedure of the test phase for both the knowledge-informant and the ignorant-informant condition. In each condition, the experimenter a) presented the object and b) covered the object in her hands and hid it in one box invisible for infants, while the knowledgeable informant observed the hiding (knowledgeable-informant condition) as opposed to the ignorant informant who explicitly turned around and looked away (ignorant-informant condition). Following to the hiding, c) the informant indicated the hidden object's location by pointing at the box in both conditions. Finally, d) the informant moved the boxes into the infant's reach to measure the infant's object-choice behavior.

Coding and Analyses

Warm-up phases. The coding and analyses of the variables in the warm-up phases was identical to the coding and analyses we used in Study 2a (see section 4.2.1 for a detailed description).

Test phase. Infants' use of the informant's indication was coded for the same variables and in the same way as in the warm-up phases. However, we did not code infants' first opening of the box in the test phase because the boxes were locked, and it was not possible for infants to open them.

Data reliability

In order to assess the inter-rater reliability for the dependent variables, a naive research assistant, who was blind to the aims and hypotheses of the study, coded half of the sample. The Intraclass-Correlation (ICC) for the inter-rater reliability for the 14-month-old sample was at least .91, $p < .001$, for all variables in the warm-up phases and it was at least .96, $p < .001$, for all variables in the object-choice test. ICC for the 20-month-old sample was at least .97, $p < .001$, for all variables in the warm-phases and it was at least .98, $p < .001$, for all variables in the object-choice test. Moreover, in order to guarantee that all trials were of identical presentation quality we excluded those trials in which the informant did not provide their suggestions of the hidden toy as it was intended (i.e., deviation from the speech protocol, or incorrect pointing gesture): 14-month-olds, warm-up phases: 4 out of 800 trials; test phase, 3 out of 396 trials; 20-month-olds, warm-up phases, 4 out of 616 trials; test phase, 2 out of 308 trials. Moreover, we also excluded those trials (14-month-olds: 99 out of 396 trials; 20-month-olds: 77 out of 308 trials) from the analyses of the object-choice test for which infants did not pay attention to the visual perspective of the informant. The reliability for the coding of the presentation quality was done for one quarter of the sample. It resulted in high correlations in the warm-up phases (14-month-olds: ICC of .91, $p < .001$; 20-month-olds: ICC of .92, $p < .001$) and the object-choice test (14-month-olds: ICC of 1.00, $p < .001$; 20-month-olds: ICC of .88, $p < .001$) for both ages.

Results

14-month-olds

Warm-up phases. We conducted Wilcoxon tests to analyze the 14-month-olds' performance in the warm-up phases. In the first warm-up phase, infants looked first at the indicated box (M = 74.8% of trials, SD = 23.7) more often than would be expected by chance (50% of trials), Z

= -7.052, $p < .001$, $r = 0.50$. We found the same pattern for infants' grasping responses. That is, infants touched the indicated box first ($M = 78.0\%$ of trials, $SD = 22.4$) more often than chance level, $Z = -7.442$, $p < .001$, $r = 0.53$; they attempted to open the indicated box first ($M = 79.1\%$ of trials, $SD = 22.0$) more often than chance level, $Z = -7.597$, $p < .001$, $r = 0.55$; and they opened the indicated box first ($M = 78.2\%$ of trials, $SD = 22.6$) more often than chance level, $Z = -7.450$, $p < .001$, $r = 0.54$.

In the second warm-up phase, infants looked at the indicated box first ($M = 71.7\%$ of trials, $SD = 23.8$) more often than would be expected by chance, $Z = -6.626$, $p < .001$, $r = 0.47$. Regarding their choice of a box we found that infants touched the indicated box first ($M = 71.9\%$ of trials, $SD = 24.2$), attempted to open the indicated box first ($M = 71.6\%$ of trials, $SD = 24.5$), and opened the indicated box first ($M = 71.7\%$ of trials, $SD = 24.4$) more than would be expected by chance, $Z = -6.354$, $p < .001$, $r = 0.46$; $Z = -6.199$, $p < .001$, $r = 0.45$; $Z = -6.193$, $p < .001$, $r = 0.45$, respectively. For a bar chart of infants' performance in the warm-up phases, see Figure 24.

Test phase. We analyzed infants' performance in the object-choice test across all trials by conducting Mann-Whitney *U* tests. Infants did not differ in their choice of the indicated box as a function of whether the knowledgeable informant or the ignorant informant provided the cue. They were indifferent in their first look at a box, $U = 823.500$, $p = .480$, $r = 0.08$, in their first touch of a box, $U = 810.500$, $p = .652$, $r = 0.05$, and in their first attempt to open a box, $U = 818.500$, $p = .845$, $r = 0.02$. For descriptive statistics see Table 7.

The same pattern of results occurred when we analyzed the first trial only (Chi-square tests): First look at the box indicated by the knowledgeable informant (indicated box: $n = 23$; not-indicated box: $n = 17$) versus the ignorant informant (indicated box: $n = 20$, not-indicated box: $n = 13$), $\chi^2 = 0.072$, $N = 73$, $p = .816$; first touch of the box indicated by the knowledgeable informant (indicated box: $n = 23$; not-indicated box: $n = 15$) versus the ignorant informant (indicated box: $n = 20$, not-indicated box: $n = 12$), $\chi^2 = 0.029$, $N = 70$, $p = 1.000$; first attempt to open the box indicated by the knowledgeable informant (indicated box: $n = 22$; not-indicated box: $n = 14$) versus the ignorant informant (indicated box: $n = 18$, not-indicated box: $n = 13$), $\chi^2 = 0.064$, $N = 67$, $p = .809$. For a bar chart of infants' performance in the test phase, see Figure 25.

20-month-olds

Warm-up phases. We conducted Wilcoxon tests to analyze the 20-month-olds' performance in the warm-up phases. In the first warm-up phase, infants looked at the indicated box ($M = 79.9\%$ of trials, $SD = 21.3$) more often than would be expected by chance (50% of trials), $Z = -$

6.850, $p < .001$, $r = 0.55$. We found the same pattern for infants' grasping responses. That is, infants touched the indicated box first (M = 81.4% of trials, SD = 25.3), attempted to open the indicated box first (M = 80.4% of trials, SD = 25.3), and opened the indicated box first (M = 81.9% of trials, SD = 23.7) more than would be expected by chance, $Z = -6.456$, $p < .001$, $r = 0.52$; $Z = -6.379$, $p < .001$, $r = 0.52$; $Z = -6.644$, $p < .001$, $r = 0.54$, respectively.

In the second warm-up phase, infants looked at the indicated box first (M = 77.7% of trials, SD = 23.1) significantly above chance level, $Z = -6.630$, $p < .001$, $r = 0.53$. Further, they touched the indicated box first (M = 76.3% of trials, SD = 23.3), attempted to open the indicated box first (M = 75.4% of trials, SD = 24.3), and opened the indicated box first (M = 75.9% of trials, SD = 23.8) significantly above chance level, $Z = -6.470$, $p < .001$, $r = 0.52$; $Z = -6.286$, $p < .001$, $r = 0.51$; $Z = -6.302$, $p < .001$, $r = 0.51$, respectively. For a bar chart of 14- and 20-month-olds' performance in the warm-up phases, see Figure 24.

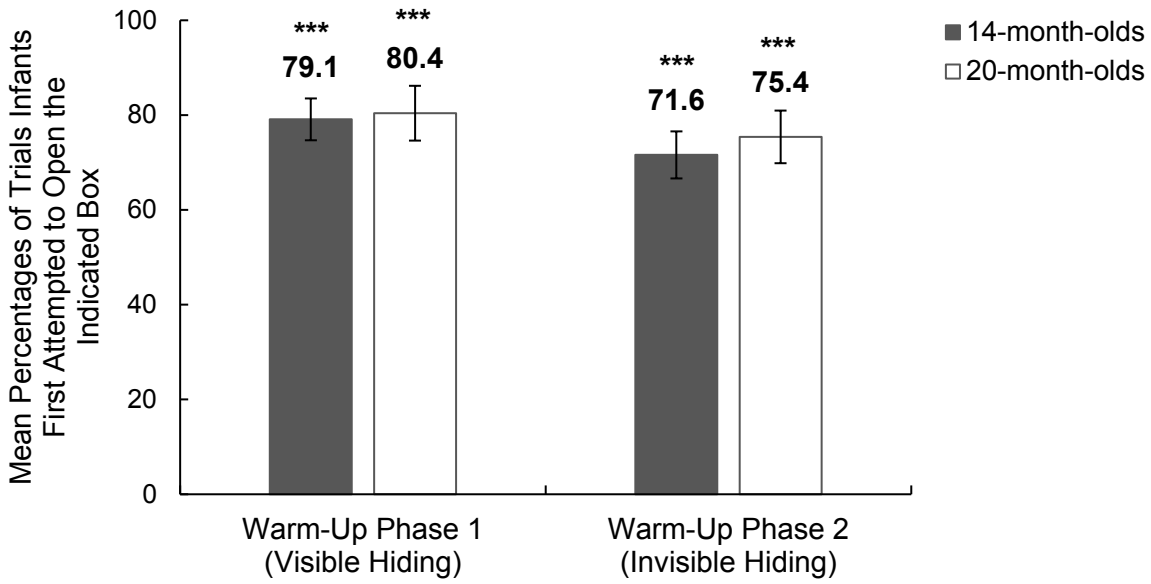

Figure 24. Study 2b: Bar chart of the warm-up phases. The graph shows the mean percentages of trials infants at 14 and 20 months of age first attempted to open the box indicated by the experimenter in both warm-up phase 1 (the toy was hidden visible for infants) and warm-up phase 2 (the toy was hidden invisible for infants). Significances are highlighted with asterisks based on Wilcoxon tests comparing infants' behavior with chance performance. Note: $^{***}p \leq .001$. Error bars show 95% confidence intervals.

Test phase. Infants' performance in the object-choice test was calculated based on Mann-Whitney U tests. In this test phase, infants did not differentiate between the knowledgeable and the ignorant informant in their first look at a box, $U = 446.500$, $p = .297$, $r = 0.13$, and their first touch of a box, $U = 380.000$, $p = .123$, $r = 0.19$. However, infants attempted to open the indicated box first more when the knowledgeable informant provided the cue (M = 77.9% of trials, SD =

23.0) than when the ignorant informant provided the cue (M = 63.8% of trials, SD = 30.8), U = 335.500, p = .038, r = 0.26. For further descriptive statistics see Table 8. For a bar chart of 14- and 20-month-olds' performance in the test phase, see Figure 25.

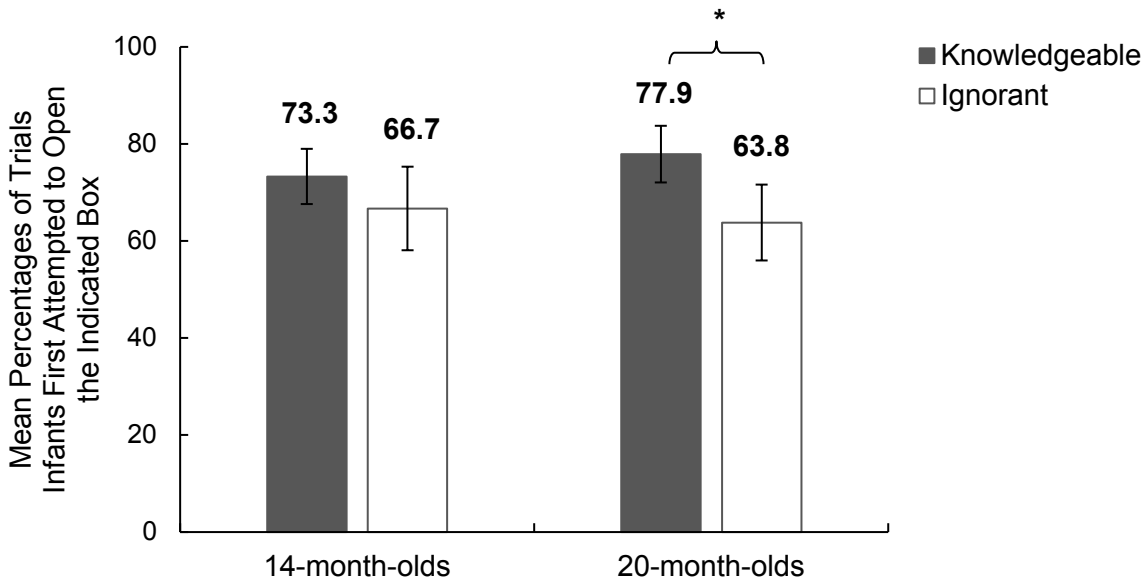

Figure 25. Study 2b: Bar chart of the test phase. The graph shows the mean percentages of trials infants at 14 and 20 months of age first attempted to open the box indicated by the knowledgeable and ignorant informant in the test phase. Significances are highlighted with asterisks based on Mann-Whitney U tests comparing the behavior of infants in the knowledgeable-informant and the ignorant-informant condition. Note: $^{*}p \leq .05$. Error bars show 95% confidence intervals.

Similar results occurred when we analyzed the first trial only (Chi-square tests): infants looked at the box indicated by the knowledgeable informant first (indicated box: n = 18, not-indicated box: n = 12) versus the ignorant informant (indicated box: n = 15, not-indicated box: n = 2) was at trend level but not significant, χ^2 = 4.136, N = 47, p = .053; first touch of the box indicated by the knowledgeable informant (indicated box: n = 19, not-indicated box: n = 7) versus the ignorant informant (indicated box: n = 13, not-indicated box: n = 2), χ^2 = 1.025, N = 41, p = .445; first attempt to open the box indicated by the knowledgeable informant (indicated box: n = 19, not-indicated box: n = 7) versus the ignorant informant (indicated box: n = 12, not-indicated box: n = 3), χ^2 = 0.247, N = 41, p = .720.

Table 8. *Study 2b: Descriptive statistics of the warm-up phases and the test phase. Mean percentages and standard deviations (in italics) of trials in which infants first looked at, first touched, first attempted to open, and first opened the box indicated by the informant in the warm-up phases and the test phase (knowledgeable vs. ignorant informant, varied between subjects) for both infants at 14 and 20 months of age.*

	14-month-olds				**20-month-olds**			
	Warm-Up 1	**Warm-Up 2**	**Know-ledgeable**	**Ignorant**	**Warm-Up 1**	**Warm-Up 2**	**Know-ledgeable**	**Ignorant**
First Look	74.8*** *23.7*	71.7*** *23.8*	73.0*** *30.4*	67.1** *34.9*	79.9*** *21.3*	77.7*** *23.1*	73.2*** *25.1*	67.0** *26.4*
First Touch	78.0*** *22.4*	71.9*** *24.2*	73.3*** *25.9*	65.2* *38.0*	81.4*** *25.3*	76.3*** *23.2*	74.3*** *25.5*	64.5* *29.3*
First Attempt	79.1*** *21.9*	71.6*** *24.5*	73.3*** *25.9*	66.7* *39.2*	80.4*** *25.3*	75.4*** *24.3*	77.9*** *23.0*	63.8* *30.8*
First Open	78.2*** *22.6*	71.7*** *24.4*	-	-	81.9*** *23.7*	75.9*** *23.8*	-	-

Note. Differences against chance performance: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$.

Differences between infants' responses at 14 and 20 months of age

Warm-up phases. There were no differences between the two age groups for any of the coded variables, neither for the first warm-up phase (Wilcoxon tests, all *p*s ≥ .137, all *r*s ≤ .12), nor for the second warm-up phase (Wilcoxon tests, all *p*s ≥ .112, all *r*s ≤ .13).

Test phase. In the object-choice test, there were no differences between the two age groups for any of the coded variables (Wilcoxon tests, all *p*s ≥ .497, all *r*s ≤ .06). This result holds also after analyzing the first trial separately (McNemar tests, all *p*s ≥ .255).

Correlations between infants' responses at 14 and 20 months of age

Infants' performance in the second warm-up phase at the age of 14 months did not correlate with their performance in the object-choice test at the age of 20 months (Spearman correlations for all dependent variables, all r_ss(62) ≤ .210, all *p*s ≥ .102). Moreover, infants' performance in the object-choice test at the age of 14 months did not correlate with their performance in the object-choice test at the age of 20 months (Spearman correlations for all dependent variables, all r_ss(58) ≤ .171, all *p*s ≥ .198).

Control Analyses

There were no effects of infants' gender for any of the two age groups, neither for the warm-up phases (Mann-Whitney *U* tests, 14-month-olds: all *p*s ≥ .217, all *r*s ≤ .12; 20-month-olds: all *p*s ≥ .406, all *r*s ≤ .10), nor for the object-choice test (Mann-Whitney *U* tests, 14-month-olds: all *p*s ≥ .380, all *r*s ≤ .10; 20-month-olds: all *p*s ≥ .176, all *r*s ≤ .17). In order to investigate whether infants followed the referential cue (i.e., the pointing gesture) irrespective of condition (knowledgeable versus ignorant informant), we compared infants' performance in the test phase to chance level. At 14 months of age, infants looked at the indicated box first (*M* = 70.2% of trials, *SD* = 32.5), touched the indicated box first (*M* = 69.5% of trials, *SD* = 32.3), and attempted to open the indicated box first (*M* = 70.2% of trials, *SD* = 32.9) significantly above chance level, Wilcoxon tests, *Z* = -4.722, *p* < .001, *r* = 0.36; *Z* = -4.504, *p* < .001, *r* = 0.35; *Z* = -4.597, *p* < .001, *r* = 0.36, respectively. At 20 months of age, too, infants looked at the indicated box first (*M* = 70.4% of trials, *SD* = 25.7), touched the indicated box first (*M* = 70.1% of trials, *SD* = 27.4), and attempted to open the indicated box first (*M* = 71.8% of trials, *SD* = 27.4) significantly above chance level, Wilcoxon tests, *Z* = -4.930, *p* < .001, *r* = 0.43; *Z* = -4.752, *p* < .001, *r* = 0.42; *Z* = -5.038, *p* < .001, *r* = 0.45, respectively. Moreover, participants' use of the pointing gesture did not differ between the second warm-up phase and the test phase, neither for 14-month-olds (Wilcoxon tests, first look, *p* = .822, all *r* = .02; first touch, *p* = .597, all *r* = .04; first attempt to open, *p* = .785, all *r* = .02), nor for 20-month-olds (Wilcoxon tests, first

look, $p = .076$, all $r = .16$; first touch, $p = .347$, all $r = .08$; first attempt to open, $p = .406$, all $r = .08$).

We further checked whether the gender of the informant had an effect on infants' performance. There were no such effects for 20-month-olds (Mann-Whitney *U* tests, all *p*s ≥ .176, all *r*s ≤ .17), and no effects occurred for 14-month-olds in the warm-up phases (Mann-Whitney *U* tests, all *p*s ≥ .110, all *r*s ≤ .16). However, infants preferred to look at the indicated box first when a male informant provided the cue ($M = 74.6\%$ of trials, $SD = 31.9$) more than when a female informant did ($M = 59.1\%$ of trials, $SD = 31.9$) during the object-choice test, Mann-Whitney $U = 518.000$, $p = .028$, $r = .24$. The same preference for the male informant was found for infants' first touch of the indicated box (male informant: $M = 73.9\%$ of trials, $SD = 31.5$; female informant: $M = 58.7\%$ of trials, $SD = 32.1$), Mann-Whitney $U = 501.500$, $p = .031$, $r = .24$, as well as marginally for infants' attempt to open the indicated box first (male informant: $M = 72.3\%$ of trials, $SD = 27.1$; female informant: $M = 60.3\%$ of trials, $SD = 27.8$), Mann-Whitney $U = 519.000$, $p = .058$, $r = .21$. Consequently, we split the group of 14-month-olds into two groups, the one presented with a male informant and the one presented with a female informant, and analyzed infants' performance in the two conditions (knowledgeable versus ignorant informant) in the object-choice test separately for the two groups. Still, the performance of both groups did not differ between conditions (Mann-Whitney *U* tests, male informant: all *p*s ≥ .519, all *r*s ≤ .08; female informant: all *p*s ≥ .551, all *r*s ≤ .13).

Discussion

In this study, we could show that both infants at 14 and 20 months of age used the informants' constant pointing gesture as an indicator for the location of a hidden object. This finding is in line with previous studies (Aureli et al., 2009; Behne et al., 2005; Behne et al., 2012; Bretherton, 1991; Carpenter, Nagell et al., 1998; Desrochers et al., 1995; Murphy & Messer, 1977; Tomasello, 1999; Tomasello & Akhtar, 1995; Woodward & Guajardo, 2002). Therewith, infants had a specific capability that served as an important prerequisite for demonstrating their mindreading skills in the test phase. Still, 14-month-olds did not differentiate between the knowledgeable and the ignorant informant when searching for the hidden object. However, about 6 months later the very same infants attempted to open the indicated box first more often when it was indicated by the knowledgeable informant than when it was indicated by the ignorant informant. Thus, in this version of the hiding-finding game, infants at 20 months of age selectively preferred to use information from a knowledgeable versus an ignorant informant.

3.2.3 Discussion of Study Set 2

The current set of two longitudinal studies examined whether infants within their second year of life use an informant's abstract and concrete referential cue and whether they, while doing so, evaluate the informants' reliability based on their knowledge states.

The use of referential cues within the first half of their second year of life

Infants at 14 months of age did not reliably use a physical marker in combination with a non-static pointing gesture as an indicator for the location of a hidden object in Study 2a. In contrast, they did use the informant's constant pointing gesture to find the object in Study 2b. Thus, when provided with a more concrete referential cue infants could use this cue to find the hidden object. Although it remains unclear which of the modifications made in Study 2b (i.e., constant pointing without marker, not using an occluder, different types of boxes, different objects) facilitated infants' use of the informants' referential cues, due to the empirical evidence on young infants' understanding of pointing gestures (e.g., Behne et al., 2005; Behne et al., 2012; Carpenter, Nagell et al., 1998), we assume that the constant pointing gesture made the crucial difference. Whereas Study 2b replicated previous findings on young infants' understanding and use of pointing gestures, Study 2a – in which the pointing gesture was non-static – illustrated the circumstances under which these young infants can use the gesture. That is, it has to be static and present while infants make their choice.

The use of others' knowledge within the first half of their second year of life

Regardless of which referential cue the informants provided, 14-month-old infants were not selective in their choice of a box in our hiding-finding games; that is, they did not base their choice on the informants' knowledge states when following a referential cue to find an object. For Study 2a, this might be due to their inability to use abstract referential cues, which was a prerequisite for making use of the informants' knowledge (see Discussion of Study 2a). However, this alone cannot explain the 14-month-olds' lack of success, since infants' looking behavior in the looking-time test also did not reveal any evidence for the expectation that the knowledgeable informant indicated the correct location of the hidden object. This is surprising given that other studies that used the violation-of-expectation paradigm provided evidence for (even younger) infants' mental state understanding (Luo & Baillargeon, 2007). Another argument that might explain both the results of the object-choice test and the looking-time test might be that infants were confused by being presented with two markers at the same time. Whereas in the warm-up phases, participants were provided with the constant association of the marker with the location of the object, they were presented with two markers but only one

hidden object in the two tests. This might have caused confusion that, in turn, prevented participants from using the markers and expecting them to be trustworthy predictors of the object's location (irrespective of who presented them). In addition, the cognitive demand to combine the color and the picture of the marker with the specific informant might have been too challenging for infants at this young age. Thus, given the demands of the paradigm used in Study 2a, this paradigm likely comprised some challenges for young infants that might explain the lack of selectivity when deciding between a knowledgeable and an ignorant informant.

However, in Study 2b, we modified all of the critical methodological aspects of Study 2a. That is, the informants provided infants with referential cues they were able to use, infants did not face conflicting information, only one informant's visual perspective had to be tracked and remembered, and there was no occluder raising demands on infants' cognitive capacities. Still, the 14-month-olds did not differentiate between a knowledgeable and an ignorant informant. Therefore, one might conclude that the ability to selectively use others' knowledge in a hiding-finding game is not present in infants at 14 months of age. This is true insofar as the infants were not selective in this paradigm. However, the control analyses revealed that participants' non-selectivity might have been influenced by the paradigm itself and, thus, we should be careful when interpreting infants' non-selectiveness beyond this paradigm. For instance, there was a pointing bias in the object-choice test: Infants preferred the indicated box for their first choice irrespective of who provided the cue (i.e., the knowledgeable or the ignorant informant). This bias might have been reinforced by infants' experiences in the warm-up phases, in which the pointing gesture was a reliable cue each time. It seems possible that infants transferred this experience into the test phase, given that there was no difference in infants' performance between the second warm-up phase and the object-choice test.

The use of referential cues within the second half of their second year of life

In Study 2a, infants at 19 months of age preferred the indicated box and, therefore, used the abstract referential cue (i.e., the marker in combination with a non-static pointing gesture) as an indicator for an object's location, in all variables measured. Thus, the older participants understood the paradigm. When comparing both age groups' performance in the warm-up phases we found evidence for a development of this ability from the first to the second half of their second year of life: 19-month-olds significantly improved in their use of the physical marker in combination with a pointing gesture. This result reflects a developmental pathway of infants' ability to make use of abstract referential cues, leading them to become appropriate members of their cultural environment which comes up with a variety of abstract referential cues to be learned and used (Tomasello, 1999; Tomasello et al., 1997).

In Study 2b, infants at 20 months of age used the constant pointing gesture as an indicator for the location of a hidden object, just like they had already done about six months before their first test. Thus, there were no relevant differences between these two age groups in their successful use of this referential cue when they did not know where the object was hidden. This suggests that infants' understanding and use of constant pointing gestures as referential cues for hidden objects seem to be relatively stable within the second year of life.

The use of others' knowledge within the second half of the second year

In Study 2a, there was no evidence that the older infants differentiated between a knowledgeable and an ignorant informant, neither for the choice of a box nor in their looking time (violation of expectation). That is, irrespective of age, infants did not take the informants' knowledge states into account when choosing a box, nor did they seem to hold the expectation that the knowledgeable informant indicated the correct location of the hidden object. However, a direct comparison of the performance of both age groups in the object-choice test revealed some differences at trend level: Infants at 19 months of age followed the knowledgeable informant's cues more than infants did at 14 months of age. Thus, the cognitive ability to recognize and take others' knowledge states into account seemed to undergo some development within the second year of life (for limitations of this interpretation see Discussion of Study 2a).

Still, one might have expected stronger results based on the cumulative evidence for infants' ability to understand others' visual perspective and knowledge states from recent studies (see section 1.2). However, the methodological demands of our study might be responsible for infants' low rates of success (see above). Moreover, in contrast to studies investigating infants' theory of mind (e.g., Buttelmann et al., 2009; Knudsen & Liszkowski, 2012), participants in our study had no knowledge about the location of the hidden object. This crucial difference, that is the need to infer others' knowledge while being ignorant themselves, might reflect another challenge for infants in the current studies. However, this alone cannot explain the lack of success in Study 2a since in the between-subjects design used in Study 2b, infants at the age of 20 months significantly preferred to attempt to open the box indicated by a knowledgeable rather than an ignorant informant. This suggests that, unlike 14-month-olds, infants at 20 months of age are selective when using information from informants who differ in terms of their knowledge states about an objects' location. This result indicates a developmental pathway within infants' second year of life, and corresponds with the empirical evidence of studies investigating infants' theory of mind and understanding of others' visual perspective (Brooks & Meltzoff, 2002; Buttelmann et al., 2009; Luo & Baillargeon, 2007; Poulin-Dubois et al., 2013; Sodian et al., 2007). It further complements the current state of knowledge about this

ability insofar that if infants themselves have no knowledge about the current state of affairs, attributing knowledge to others about it seems challenging, at least until the middle of the second year of life.

One might argue that the fact that we found evidence for the tracking of others' knowledge states for only one (i.e., infants' first attempt to open a box) out of three variables (i.e., infants' first touch of a box, and their first look at a box) limits this finding. However, infants' first attempt to open a box reflects the most meaningful variable in this test phase, since this reflects infants' choice about which box to search for the object. In contrast, the first touch of a box and the first look at a box might simply indicate infants' curiosity.

Moreover, since infants succeeded only in a between-subjects design, we do not know whether infants would indeed prefer a knowledgeable over an ignorant informant when presented with both at the same time. As we claimed in our first study, it might be too difficult for infants to track and keep in mind the visual perspective of two informants at the same time. These current results illustrate the presence of the core ability to differentially evaluate the reliability of informants based on their knowledge states in infants at 20 months of age. To investigate when in ontogeny infants can use this ability flexibly is a task for future research.

Control Analyses

One effect of the control analyses that we have not discussed thus far is that 14-month-old infants in Study 2a preferred to look first at the box with the yellow marker. This preference could be due to the color of the marker or the picture of the yellow-clothed informant on the marker. We have three comments to this effect: First, it does not suggest a strong preference, because it only affected infants' first look at a box, not infants' grasping behavior (first touch, first attempt to open a box, first opening of a box). Second, it is unlikely that this preference is due to the infants' perception of the yellow-clothed informant as the more reliable informant in this hiding-finding game, since this looking preference did not affect infants' decision when searching for the object by grasping a box. Third, we made sure to involve two informants who looked as similar as possible and mainly differed only in their outfit.

Limitations

Since the present studies were conducted based on a longitudinal design, we have to discuss the effects between the two age groups against the background of possible learning effects. This, for example, raises the question whether the older infants in Study 2a used the physical markers in combination with the pointing gesture more because they had already experienced this study about five months earlier. Note that the same infants who participated at 14 months

of age did not use these referential cues in order to find the hidden object in all the variables. That is, the ability to use these types of cues was not found to be present in this age group and, thus, had to develop sometime after the first experimental appointment. Even if infants had shown this ability in the first appointment, they would have needed to remember the function of the physical marker in combination with the pointing gesture five months later. Accordingly, one could argue that infants' increased tendency to use the informants' knowledge states in both studies is mainly due to learning effects. However, the order of the informants' knowledge states was counterbalanced between the two appointments. That means, infants never saw the same informant being knowledgeable or ignorant in the first and the second appointment: The allocation of which of the two informants was knowledgeable or ignorant in Study 2a, and whether the one informant was knowledgeable or ignorant in Study 2b, changed for each infant from the first to the second participation. Therefore, it was not possible that the tendency of infants' increased use of the informants' knowledge states in their second appointment was due to their previous experiences of the informants' knowledge states in the first appointment. However, it is possible that infants in the second experimental appointment were a bit more familiar with the laboratory and the experimenters. This might have facilitated the situation for infants in the second appointment, that is, it is possible that infants could direct more of their attention to the hiding-finding game itself than to the completely new rooms and people around them. This, in turn, could have increased infants' understanding and use of the referential cues and the informants' knowledge states within their second half of their second year of life. The abilities itself, however, were unlikely to have been influenced by infants' first participation at 14 months of age.

An important limitation of the current study concerns the comparably broad age range of infants in their second participation. Whereas the age range of infants was approximately 2 months during the first set of appointments (Study 2a: age range = 12 months; 29 days to 15 months; 4 days, *SD* = 0 months; 18 days; Study 2b: age range = 12 months; 30 days to 15 months; 6 days, *SD* = 0 months; 15 days), it was approximately 3 months (Study 2a) or 5 months (Study 2b) when the infants participated in the second set of appointments (Study 2a: age range = 17 months; 3 days to 20 months; 0 days, *SD* = 0 months; 23 days; Study 2b: age range = 18 months; 12 days to 23 months; 7 days, *SD* = 1 months; 0 days). This was mainly due to occasional difficulties in timely invitation of the same parents and infants to the possible testing times in the second appointment (e.g. earlier appointments due to parents' moving, postponements due to infants' illness or family vacation, and so on). To exclude infants from the analyses would have required subjective criteria concerning the age range, which would

have been difficult to justify. We claim to make statements about 19-month-olds and 20-month-olds given the mean age of 18 months and 25 days (Study 2a) and 20 months and 1 day (Study 2b), respectively. However, we would like to point out that one has to be careful when interpreting our results with respect to the precise participants' age. We recommend, particularly in terms of participants in the second appointment of Study 2b, taking our data as evidence arising from a sample of infants in the second half of their second year of life.

Advantages and future research

Ultimately, the longitudinal design in both studies reflects a crucial advantage of our study in that we were able to compare the behavior of the very same infants and, thus, the comparison of the two age groups is not confounded by two different groups of infants. We investigated the same questions about infants' use of referential cues and others' knowledge by conducting two longitudinal studies with different methodological designs and procedures and, thus, are able to provide varied insights about the development of these abilities during a hiding-finding game. The modified paradigm of the second study in particular contains profound potential for future research to investigate infants' selective social learning.

Conclusion

All in all, the present set of studies contributes important new evidence concerning the development of infants' use of concrete and abstract referential cues and an informant's knowledge state when searching for a hidden object. Our results indicate two developmental pathways that occur within the second year of life. First, the use of more abstract referential cues significantly increases between infants' first and second half of their second year of life (Study 2a). Second, infants tend to find knowledgeable informants more trustworthy at 19 months of age than they do at 14 months of age (Study 2a), and, complementarily, infants at 20 months of age but not at 14 months of age successfully take informants' knowledge states into account when using their referential cues (Study 2b). Finally, both infants' use of referential cues as well as their use of others' knowledge – two fundamental abilities necessary for sharing information and learning within the social environment surrounding them – seem to develop within infants' second year of life.

3.3 Study 3: Infants' Selectivity due to Informants' Familiarity

Another open question in developmental psychology research concerns the impact of an informant's familiarity on the selective social learning of infants in their second year of life. Compared to Study Set 1, the current study manipulated the informants' familiarity by presenting infants with a hiding-finding game. As mentioned in section 1.3, there are many reasons why infants might show a clear preference for familiar over unfamiliar informants. However, the empirical evidence is contradictory with regard to the studies that used a social referencing paradigm. Moreover, in most of the previous studies, including Study 1a of the present dissertation, there was no need for infants to decide between the familiar and unfamiliar informant within a trial, which is important to have data about infants' real decisions rather than mere analytical comparisons of infants' performance in different trials. For those reasons, Study 3 was designed to fill this gap in the research. In this study, we manipulated the informants' familiarity within subjects and, thus, each infant had to decide within each trial from which informant they look for and use information about the location of a hidden object. We presented infants with both an *unfamiliar informant* (i.e., the experimenter) and a *familiar informant* (i.e., the infants' parent). By using this paradigm in combination with a longitudinal design, we were able to investigate the development of the influence of the informants' (un)familiarity on infants' information search and use. This, in turn, represents an important contribution to the field of research investigating infants' selective social learning. With respect to attachment theory (Ainsworth, Blehar, Waters, & Wall, 1978; Bowlby, 1969) and the remarkable percentage of life time infants shared information with their parents as opposed to the novel experimenter, as well as with respect to the empirical evidence emphasizing infants' preference for familiar over unfamiliar stimuli and informants (see section 1.3), we predict that both infants at 14 months of age and infants at 20 months of age look for and use information predominantly from the familiar informant. For an overview of the manipulated variable (i.e. highlighted in green), the medium and entity, as well as the infants' age, of Study 3, see Figure 26.

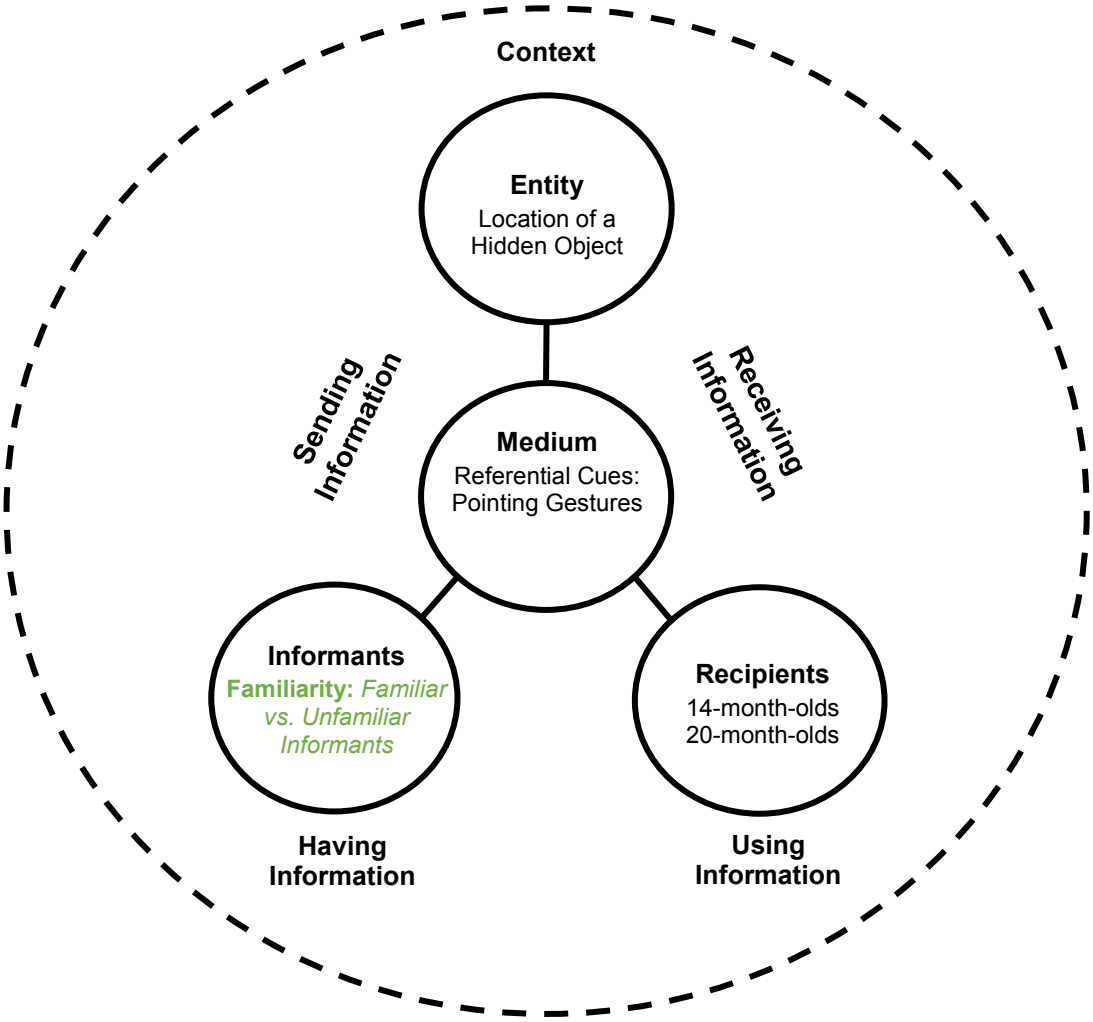

Figure 26. Overview of Study 3 based on the Organon model.

Method

Participants

The sample consisted of 99 infants at an age of 14 months (mean age = 13 months; 27 days, age range = 12;30 to 15;6, 49 females, 50 males). One additional infant was tested but excluded from the analyses due to fussiness. Moreover, we invited all infants again, approximately 6 months after their first appointment. A total of 77 infants participated in this second appointment (mean age = 20 months; 1 day, age range = 18;12 to 23;7, 36 females, 41 males). Infants in this study subsequently also participated in Study 2b. Participants were recruited from a database of parents who agreed to participate in child development studies in a mid-sized German city. In addition to their general agreement, parents signed a consent form for participating in the

current study for both experimental appointments prior to testing. Each infant received a toy and a certificate after each participation.

Apparatus and stimuli

For the experiment, the infant sat at a table in a high chair. The assistant sat opposite to the infant at the same table. In the warm-up phase, the parent and the experimenter sat at the left and the right side of the infant slightly behind her/him, whereas in the test phase both the experimenter and the parent moved at the left and the right side of the assistant. One camera was placed opposite the infant in order to record the infant's gazing behavior and hand movements towards the boxes. A second camera was placed behind the infant to record the overview of the experimental set up and every ones' acting. In each trial, the assistant hid an object (a little colored toy with wobble eyes, 3.5 cm wide and deep, and 5 cm high, see Figure 1) in one of two grey boxes (15 cm diameter, and 8 cm high, see Figure 2). The lids of the boxes changed in their color (i.e., grey or white) after each trial in order to decrease perseveration errors (Behne et al., 2012). The ground of both boxes was equipped with soft cloth to ensure a silent drop when hiding the toys in the boxes. Moreover, there was a little cardboard container (also provided with soft cloth) fixed below the table at the assistant's side. This container was used in the test phase to put in the toys (see procedure). A little table below the testing table served as a storage for the eight toys, as well as the watch (to stop the time) and order sheets.

Procedure

After participants' arrival, the parent filled out a consent form and the assistant played with the infant and explained the procedure to the parent without mentioning any hypotheses of the study. Then, after entering the testing room, half of the parents were asked to play free with their infants on a carpet with certain toys for five minutes. The other half of parents were asked to do this after the experiment. These parent-infant interactions were videotaped. However, this study does not focus on this data. Since there is no difference in infants' acting in the hiding-finding game between infants who were engaged in a free play interaction with their parents prior the experiment and infants who played with their parents after the experiment (14-month-olds: all ps $\geq .288$; 20-month-olds: all ps $\geq .118$), this manipulation does not affect the results reported in this study. Before the experiment started, the experimenter taught the parent the procedure at the testing apparatus. This was done due to the experiences of a pilot study revealing the necessity of acting out the procedure with the parent prior to the experiment in order to ensure the quality of parents' performance. Meanwhile, the assistant played with the

infant at the other side of the room and ensured that the infant paid attention to the play rather than the parent's training. After this training the experiment started.

Warm-Up phase. The procedure of the warm-up phases was identical to Study 2b (see section 3.2.2 for a detailed description). Infants received eight trials in which the assistant hid the toy in one of the two boxes. Within the first four trials, this hiding action was visible to participants, that is, infants could observe in which box the assistant hid the toy. However, in the second four trials of the warm-up phase, infants could not observe the hiding action since the toy was covered in the assistant's hands while s/he moved the toy in one of the two boxes.

Test phase. In the test phase, participants received another four trials in which the assistant pretended to hide the toy, and both the experimenter and the parent gave different suggestions about the location of the hidden toy by pointing at different boxes. For this, the experimenter and the parent took a seat to the assistant's right and left side (side counterbalanced). The gender of both informants – the experimenter and the parent – was always kept the same. That is, there was a female experimenter when the mother acted the parent's role and a male experimenter when the father acted the parent's role to control for gender. Since the study was conducted by a male and a female researcher, the assistant's gender was always the opposite of the experimenter's gender.

The hiding procedure in the test phase differed to that of the warm-up phase. The assistant now used a new set of toys (see Figure 7) to minimize carryover-effects (e.g., based on associations between certain toys and their location in the warm-up phase). Like in the warm-up phase, the assistant held the toy between her/his hands and tapped with the toy between both boxes while s/he said "Look what I have here!"[37] Then s/he said "Look!"[38] and repeated the tapping. Following this and different to the warm-up phase, the assistant now only pretended to hide the toy. This was done because at test the boxes were locked in order to avoid feedback about the reliability of the two informants. Otherwise, if infants found the toy in the box indicated by the parent in the first test trial, they might simply follow the parent's indications in the subsequent trials solely because of this experience. Before the assistant pretended to hide the toy in one of the two boxes s/he said "Pay attention!"[39], held the toy in both hands, moved it below the table, put the toy in a little cardboard container invisible to infants, and, identically to the warm-up phase, moved both hands up so that each hand was positioned above a box – the left hand over the left box and the right hand over the right box. The assistant then moved both hands into the boxes – the left hand into the left box and the right hand into the right box

[37] Original German wording: "Schau mal was ich hier habe!"
[38] Original German wording: "Sieh' mal!"
[39] Original German wording: "Pass auf!"

–, and opened both hands while pretending to put the toy into a box and said "I put it in here!"[40] Like in the warm-up phase, the assistant striped with both backhands the boxes when s/he took out her/his hands (see procedure of the warm-up phase). Then, the assistant closed both boxes simultaneously by putting the lids on the boxes. In this phase, s/he put the lids in the correct way, so that infants were not able to open the boxes (see Figure 8). The whole hiding action was observed by both informants, that is, both the experimenter and the parent knew the correct location of the toy.

Then the assistant asked "Where is the thing?"[41] and waited for 10 seconds (by looking at a watch centrally located below the table). During these 10 seconds, the experimenter and the parent looked at the infant. The aim of this information-search phase was to provide infants with the possibility to look for information about the location of the toy by referencing at the two informants. After the information search phase, the assistant slightly moved the boxes forward (still out of infants' reach) and said "So!" as a signal for the experimenter and the parent to provide their cue about the location of the hidden toy. To do so, one after another (counterbalanced) pointed at the box next to her/him, looked at it and said "It is in here!"[42] Then s/he alternated gaze between the infant and the target box while saying "Here it is!"[43] While the informant who suggested a box first maintained her/his pointing gesture towards the box, the other informant started to give her/his cue by performing exactly the same action, but pointing at the other box. Both informants maintained their pointing gesture at the boxes while the assistant asked the infants "Where is the thing?"[44] and moved the boxes into the infants' reach. Participants could now search for the object for a maximum response time of 60 seconds. The assistant moved the boxes back as soon as infants tried to open a box or after 60 seconds elapsed, and the next trial started. After half of the trials (i.e., two out of four) both informants switched their sitting position to control for infants' side preferences when choosing a box. For an illustration of the procedure in the test phase, see Figure 27. In this figure, we additionally included the infant's corresponding reactions to the respective sequences of the hiding procedure, exemplifying infants' motivation and curiosity in the hiding-finding game, the apparent ignorance about the object's location as well as the consideration of the informants and their provided information.

[40] Original German wording: "Hier leg' ich es rein!"
[41] Original German wording: "Wo ist das Ding?"
[42] Original German wording. "Es ist hier drin!"
[43] Original German wording: "Hier ist es drin!"
[44] Original German wording: "Wo ist das Ding?"

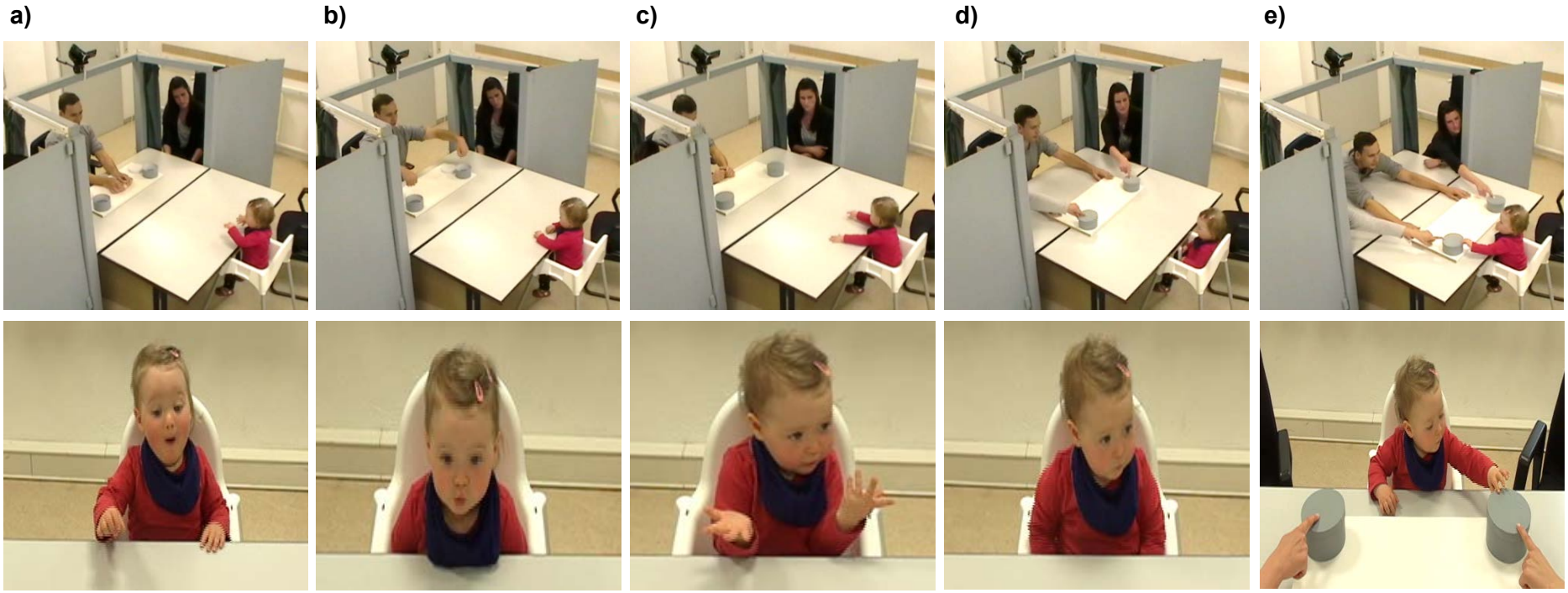

Figure 27. Study 3: Hiding procedure of the test phase. This figure shows the overview of the hiding procedure (first row of pictures) and the infant's reactions in the corresponding sequence (second row of pictures) in the test phase. In this phase, a) the experimenter presented the object and then b) covered the object in his hands to hide it in one box invisible for infants. Afterwards, c) the experimenter asked for the object's location and the informants only looked at the infant, while the infant's looking behavior at the informants was measured (information search). Following to this information-search phase, d) both the familiar and the unfamiliar informant (sitting behind the left and right sidewall, respectively) provided conflicting information about the hidden object's location by pointing at different boxes. Finally, e) the experimenter moved the boxes into the infant's reach to measure the infant's first choice of a box when searching for the object (information use).

After finishing the experiment, the experimenter, the assistant, the parent, and the infant went back to the play area where the experimenter explained the hypotheses and ideas of the study to the parent. The experiment lasted approximately 25 minutes. The whole session was videotaped.

Coding and Analyses

Warm-up phase. The coding and analyses of the variables in the warm-up phases was identical to the coding and analyses we used in Study 2a and Study 2b (see section 3.2.1 and section 3.2.2 for a detailed description).

Test phase: Information search. In order to measure infants' information search we coded their looking behavior in the test phase for three variables (first look, looking time and joint engagement) beginning with the assistant's question "Where is the thing?" after s/he hid the toy and ending after 10 seconds. Infants' first look was coded when infants looked first at one of the two informants – the experimenter versus the parent. The first look at the experimenter was coded as '0', the first look at the parent was coded as '1'. If there was no look at any of the informants within those 10 seconds this was coded as a missing value. Moreover, looking time was coded frame by frame (50 frames per second) whenever the infant looked at one of the following three areas: the parent's face, the experimenter's face, or the hiding area. The hiding area contained both the assistant and the boxes because it was not able to reliable differentiate participants' looking between these two areas. We then calculated the percentages of looking time (10 seconds) for each of the three areas separately. Joint engagement was measured as an indicator for the level at which infants related the hiding area with the informants, and thus consisted of the number of gazes infants shifted between the hiding area and each of the two informants (Carpenter, Nagell et al., 1998). Thus, one variable represented the number of gaze switches between the experimenter and the hiding area, and another variable represented the number of gazes switched between the parent and the hiding area.

Test phase: Information use. Infants' use of the informants' information was coded for infants' looking response (i.e., first look at a box) as well as infants' grasping response (i.e., first touch of a box, first attempt to open a box) beginning with the assistant's second question "Where is the thing?" directly after both informants provided their suggestions of where the toy was hidden, until a maximum of one minute response time. For participants' first look at a box as their looking response it was coded as '0' when infants looked first at the experimenter's box, and it was coded as '1' when infants looked first at the box suggested by the parent. Furthermore, for participants' grasping response we coded infants' first touch of a box and their first attempt to open a box. The first touch of a box was coded whenever infants first touched a

box with their hands ('0' = suggested by the experimenter; '1' = suggested by the parent). The first attempt to open a box was coded whenever infants tried to move up the lid of the box with their hands ('0' = suggested by the experimenter; '1' = suggested by the parent). We did not code the first opening of the box in the test phase because the boxes were closed and it was not possible for infants to open them.

Data reliability

In order to assess the inter-rater reliability for the dependent variables, a naive research assistant, who was blind to the aims and hypotheses of the study, coded 50% of the sample. The Intraclass-Correlation (ICC) for the inter-rater reliability was at least .912, $p < .001$, for all variables in the warm-up phase for the 14-month-olds, it was at least .966, $p < .001$, for all the variables in the warm-phase for the 20-month-olds, it was at least .985, $p < .001$, for all variables of infants' information use in the test phase for the 14-month-olds, and it was at least .955, $p < .001$, for all the variables in the test phase for the 20-month-olds. ICC for infants' looking behavior in the test phase was at least .866, $p < .001$, for the 14-month-olds, and it was at least .921, $p < .001$, for the 20-month-olds. In order to guarantee that all trials were of identical presentation quality we excluded those trials in which the assistant in the warm-up phases (14-month-olds, $n = 4$ out of 800 trials; 20-month-olds, $n = 4$ out of 616 trials), the parent or the experimenter in the test phases (14-month-olds, $n = 9$ out of 396 trials; 20-month-olds, $n = 8$ out of 308 trials) did not provide their suggestions of the hidden toy as it was intended (i.e., verbal hint in combination with the maintained pointing gesture to the correct box). Moreover, we also excluded those trials ($n = 17$ out of 396 trials) in the test phase of infants' information search, in which any disruptive factors occurred (i.e., verbal comments or facial movements that could have influenced infants' looking behavior). The reliability for the presentation quality was coded for one quarter of the sample. It resulted in high correlations for both the warm-up phases (14-month-olds: ICC of .913, $p < .001$; 20-month-olds: ICC of .911, $p < .001$) and the test phase (14-month-olds: ICC of .947, $p < .001$; 20-month-olds: ICC of .938, $p < .001$).

Results

14-month-olds

Warm-up phases. The results of the first and the second warm-up phase for infants at 14 months of age were identical to the results of the warm-up phases in Study 2b since both the current Study 3 and Study 2b tested the same infants in different test tasks that were preceded by the same warm-up phases. Thus, see section 3.2.2 for the results of the warm-up phases.

Test phase: Information search. To analyze 14-month-olds' looking behavior in the test phase we conducted Wilcoxon tests. Infants first looked at the unfamiliar rather than the familiar informant, Z = -2.305, p = .021, r = 0.17. Moreover, they looked longer at the unfamiliar informant than at the familiar informant, Z = -3.343, p = .001, r = 0.24, and they also switched gazes more between the unfamiliar informant and the hiding area rather than between the familiar informant and the area, Z = -2.421, p = .015, r = 0.18. For descriptive statistics see Table 9. For a bar chart of infants' looking behavior in the test phase, see Figure 28.

This pattern of results remained mainly the same when we analyzed only the first trial: More infants looked first at the unfamiliar (n = 54) than at the familiar informant (n = 31), Binominal test, N = 85, p = .017. Moreover, they looked longer at the unfamiliar informant than at the familiar informant, Z = -2.309, p = .021, r = 0.17. However, in the first trial, infants switched gazes equally often between the unfamiliar informant and the hiding area and between the familiar informant and the hiding area, Z = -1.809, p = .070, r = 0.13.

Test phase: Information use. In order to answer the question whether infants used more information provided by the familiar or the unfamiliar informant, we compared infants' first look at a box as well as their first touch of a box and first attempt to open a box based on Wilcoxon tests. Infants did not show any preference for any of the informants in neither for the first look at a box, Z = -0.592, p = .554, r = 0.04, nor their first touch of a box, Z = -1.286, p = .198, r = 0.10, nor their first attempt to open a box, Z = -1.067, p = .286, r = 0.08. For descriptive statistics see Table 9.

This pattern of results remained the same when we analyzed only the first trial. Infants showed no preference for an informants in neither their first look at a box (unfamiliar informant: n = 54 participants; familiar informant: n = 37; Binominal test, N = 91, p = .093), their first touches of a box (unfamiliar informant: n = 45; familiar informant: n = 38; Binominal test, N = 83, p = .510) nor their first attempt to open a box (unfamiliar informant: n = 47; familiar informant: n = 36; Binominal test, N = 83, p = .272).

To investigate whether most of the 14-month-olds were selective in terms of the familiarity of informants in the test phase, we analyzed the frequencies of infants with a preference (i.e. infants first attempted to open the box indicated by the experimenter or the parent in at least 75% of trials[45]) or without a preference (i.e. infants first attempted to open the box indicated by the experimenter or the parent in 50% of trials). Accordingly, 36.0% of infants (n = 27) did not show such a preference, whereas 64.0% of infants (n = 48) did. This difference between

[45] In this analysis, we excluded those participants (14-month-olds: n = 10; 20-month-olds: n = 15) for whom only 3 trials could be analyzed (e.g. due to infants' fussiness or parental errors) since we do not know whether their performance in the fourth trial would have led to a 50% or an at least 75% performance across all trials.

approximately 1/3 of infants without a preference and 2/3 of infants with a preference is statistically significant, Binomial-test, $N = 75$, $p = .020$ (see Figure 29).

20-month-olds

Warm-up phases. The results of the first and the second warm-up phase for infants at 20 months of age were identical to the results of the warm-up phases in Study 2b since both the current Study 3 and Study 2b tested the same infants in different test tasks that were preceded by the same warm-up phases. Thus, see section 3.2.2 for the results of the warm-up phases.

Test phase: Information search. As we did in the first appointment, we analyzed infants' first look at one of the informants, their looking time at the informants as well as their gaze switches between an informant and the hiding area based on Wilcoxon tests. Infants first looked at the unfamiliar rather than the familiar informant, $Z = -3.846$, $p < .001$, $r = 0.33$. Moreover, they looked longer at the unfamiliar informant than at the familiar informant, $Z = -2.741$, $p = .006$, $r = 0.23$, and they switched more gazes between the unfamiliar informant and the hiding area rather than between the familiar informant and the hiding area, $Z = -3.544$, $p < .001$, $r = 0.30$. For descriptive statistics see Table 9. For a bar chart of infants' looking behavior in the test phase, see Figure 28.

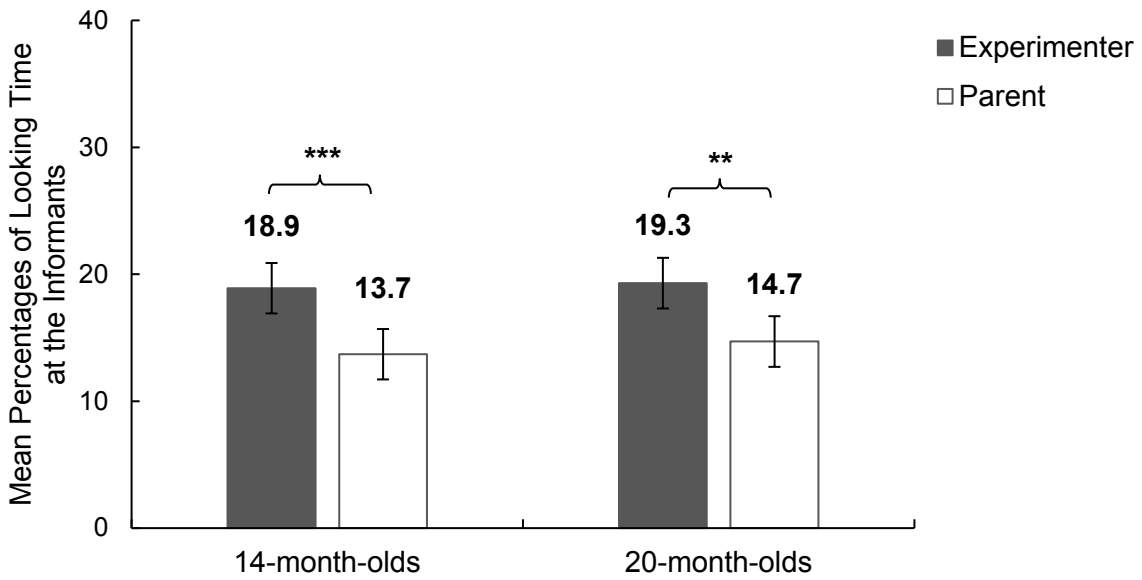

Figure 28. Study 3: Bar chart of infants' looking time. The graph shows for 14- and 20-month-olds separately the mean percentages of time that infants looked at both the experimenter and their parent in the test phase. Significances are highlighted with asterisks based on Wilcoxon tests comparing infants' looking time at the experimenter with infants' looking time at their parent. Note: $^{**}p \leq .01$, $^{***}p \leq .001$. Error bars show 95% confidence intervals.

This pattern of results remains the same when we analyzed only the first trial: Infants first looked at the unfamiliar (n = 41) rather than the familiar informant (n = 22), Binominal test, N = 63, p = .023. Moreover, they looked longer at the unfamiliar informant than at the familiar informant, Z = -2.400, p = .016, r = 0.30, and they switched more gazes between the unfamiliar informant and the hiding area than they did between the familiar informant and the hiding area, Z = -2.217, p = .027, r = 0.28.

Test phase: Information use. As we did in the first appointment, we compared infants' first look at a box as well as their first touch of a box and first attempt to open a box by conducting Wilcoxon tests. Infants did not show any preference for none of these variables, neither for the first look at a box, Z = -0.858, p = .391, r = 0.07, nor for the first touch of a box, Z = -0.160, p = .873, r = 0.01, or the first attempt to open a box, Z = -0.112, p = .911, r = 0.01. For descriptive statistics see Table 9.

This pattern of results remains the same for the first trial: first look at the box indicated by the unfamiliar informant (n = 31) versus the familiar informant (n = 29), Binominal test, N = 60, p = .897; first touch of the box indicated by the unfamiliar informant (n = 23) versus the familiar informant (n = 34), Binominal test, N = 57, p = .185; first attempt to open the box indicated by the unfamiliar informant (n = 24) versus the familiar informant (n = 34), Binominal test, N = 58, p = .237.

To investigate whether most of the 20-month-olds were selective in terms of the familiarity of informants in the test phase, we analyzed the frequencies of infants with a preference (i.e. infants first attempted to open the box indicated by the experimenter or the parent in at least 75% of trials[46]) or without a preference (i.e. infants first attempted to open the box indicated by the experimenter or the parent in 50% of trials). Accordingly, 50.0% of infants (n = 26) did not show such a preference, whereas 50.0% of infants (n = 26) did, which did not result in a difference between both groups, Binomial-test, N = 52, p = 1.000 (see Figure 29).

[46] In this analysis, we excluded those participants (14-month-olds: n = 10; 20-month-olds: n = 15) for whom only 3 trials could be analyzed (e.g. due to infants' fussiness or parental errors) since we do not know whether their performance in the fourth trial would have led to a 50% or an at least 75% performance across all trials.

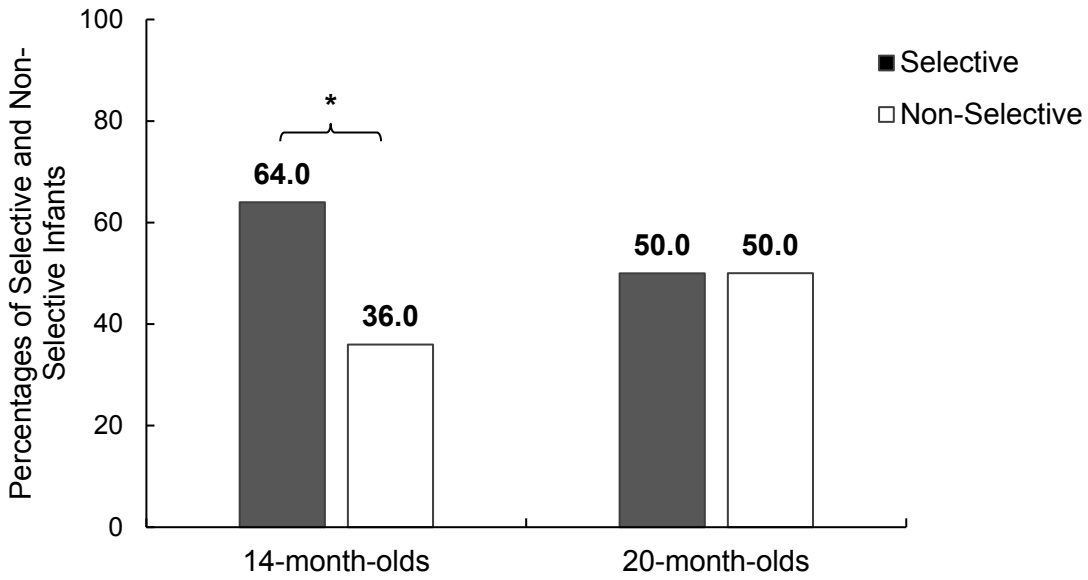

Figure 29. Study 3: Bar chart of infants' selectivity. The graph shows for 14- and 20-month-olds separately the percentages of infants with a selective (i.e. infants first attempted to open the box indicated by the experimenter or the parent in at least 75% of trials) or a non-selective (i.e. infants first attempted to open the box indicated by the experimenter or the parent in 50% of trials) performance in the test phase. Significances are highlighted with asterisks based on Binomial tests comparing the number of selective and non-selective infants. Note: $^{*}p \leq .05$.

Table 9. *Study 3: Descriptive statistics of the test phase. Mean percentages and standard deviations (in italics) of trials infants at 14 and 20 months of age first looked at the experimenter or the parent; mean percentages of time infants looked at the experimenter and the parent (in seconds); mean amount of gazes infants switched between the experimenter or parent and the hiding situation; mean percentages of trials infants first looked at the box indicated by the experimenter vs. the parent; and mean percentages of trials infants first touched the box indicated by the experimenter vs. the parent in the test phase.*

	14-month-olds		**20-month-olds**	
	Experimenter	**Parent**	**Experimenter**	**Parent**
	M	***M***	***M***	***M***
	SD	***SD***	***SD***	***SD***
First Look at the Informant	56.9*	43.1*	65.0***	35.0***
	28.8	*28.8*	*26.6*	*26.6*
Looking Time	18.9***	13.7***	19.3**	14.7**
	11.5	*8.7*	*10.6*	*9.4*
Gaze Switches	1.7*	1.4*	2.3***	1.8***
	0.9	*0.3*	*1.2*	*1.2*
First Look at a Box	51.9	48.1	53.0	47.0
	27.9	*27.9*	*28.5*	*28.5*
First Touch of a Box	46.0	54.0	48.6	51.4
	27.9	*27.9*	*25.7*	*25.7*
First Attempt to Open a Box	46.8	53.2	48.8	51.2
	28.4	*28.4*	*27.1*	*27.1*

Note. Differences between both informants: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$.

Differences between infants' responses at 14 and 20 months of age

In this part we wanted to investigate whether infants' performance in the warm-up phases and the test phases differed between the age of 14 and 20 months. Thus, we compared infants' performance in all the variables between the first and the second experimental appointment.

Warm-up phases. Based on Wilcoxon tests, there were no differences between the two experimental appointments for none of the coded variables across all trials, neither in the first warm-up phase (all ps ≥ .137, all rs ≤ .12), nor in the second warm-up phase (all ps ≥ .112, all rs ≤ .13). This result holds also for only the first trial in the second warm-up phase (McNemar tests, all ps ≥ .327) and for infants' first touch, first attempt, and first opening of the indicated box in the first warm-up phase (McNemar tests, all ps ≥ .344). However, in the first warm-up phase, infants preferred to look first at the indicated (n = 62) compared to the empty box (n = 11) more in the second appointment than they did in the first appointment (n = 50 at the indicated box, n = 23 at the empty box), McNemar test, p = .036.

Test phase. We analyzed the differences in participants' performance in the test phase between the first and the second appointment by conducting Wilcoxon tests. There was a difference between the two experimental appointments for participants' first look at the informants: 14-month-olds' preference for the unfamiliar over the familiar informant in their first look (score: $M_{\text{unfamiliar}}$ - M_{familiar} = 13.8% of trials, SD = 57.5) significantly increased until they reached the age of 20 months (score: $M_{\text{unfamiliar}}$ - M_{familiar} = 29.9% of trials, SD = 53.1), Z = -2.143, p = .032, r = 0.17. No differences between the two age groups could be found for infants' looking time at the informants and their gaze switches between the informants and the hiding area (Wilcoxon tests, all ps ≥ .188, all rs ≤ .11). There were no differences for only the first trial (McNemar tests, all ps ≥ .219). Moreover, there were no differences between the two age groups concerning their information use, neither across all trials (Wilcoxon tests, all ps ≥ .372, all rs ≤ .08), nor when analyzing only the first trial (McNemar tests, all ps ≥ .230). Moreover, there was no significant longitudinal difference in terms of the proportion of selective and non-selective participants, Chi-Square test, χ^2 = 2.475, N = 127, p = .116.

Correlations between infants' responses at 14 and 20 months of age

Between age groups, there were no correlations for none of the single variables, neither for infants' information search across all trials (Spearman correlations, all r_ss(66) ≤ .218, all ps ≥ .078) and only the first trial (Spearman correlations, all r_ss(58) ≤ .127, all ps ≥ .342), nor for infants' information use across all trials (Spearman correlations, all r_ss(59) ≤ .104, all ps ≥ .431) and only the first trial (Spearman correlations, all ps ≥ .101, all r_ss(51) ≤ .232).

Control Analyses

There were no differences between infants' gender, neither for 14-month-olds (Mann-Whitney *U* tests, warm-up phases: all *p*s ≥ .217, all *r*s ≤ .12; test phase: all *p*s ≥ .307, all *r*s ≤ .11), nor for 20-month-olds (Mann-Whitney *U* tests, warm-up phases: all *p*s ≥ .406, all *r*s ≤ .10; test phase: all *p*s ≥ .339, all *r*s ≤ .12). Moreover, we checked for differences between infants who had their mother as parent and a female experimenter and infants who had their father as parent and a male experimenter. Since the parent and the experimenter always had the same gender we do not know whether differences are due to the parents' or the experimenter's gender. For the 14-month-olds, there were no differences for the warm-up phase (Mann-Whitney *U* tests, all *p*s ≥ .110, all *r*s ≤ .16), and also no differences for the test phase in terms of infants' first look and looking time at an informant, their gaze switches between the informants and the hiding area, and their first look at box (Mann-Whitney *U* tests, all *p*s ≥ .716, all *r*s ≤ .04). However, infants first touched the box suggested by the parent more when the parent and the experimenter were male adults (M = 62.2% of trials, SD = 22.5) than when they were female adults (M = 50.4% of trials, SD = 29.4), Mann-Whitney U = 563.500, $N_{mothers}$ = 60, $N_{fathers}$ = 26, p = .037, r = 0.22. Similarly, infants first tried to open the box suggested by the parent more when the parent and the experimenter were male adults (M = 62.2% of trials, SD = 22.5) than when they were female adults (M = 49.3% of trials, SD = 29.9), Mann-Whitney U = 538.000, $N_{mothers}$ = 59, $N_{fathers}$ = 26, p = .025, r = 0.24. For the 20-month-olds, there were neither differences in the warm-up phases (Mann-Whitney *U* tests, all *p*s ≥ .270, all *r*s ≤ .13), nor in the test phase (Mann-Whitney *U* tests, all *p*s ≥ .369, all *r*s ≤ .11). Moreover, we analyzed for differences between infants who saw at first the parent's suggestion and infants who saw at first the experimenter's suggestion in the first trial to check whether the informant who first provided infants with information had more influence on infant's choices than the informant who subsequently provided information about the hidden toy. There was no difference between these two groups, neither for the 14-month-olds (Mann-Whitney *U* tests, all *p*s ≥ .577, all *r*s ≤ .06), nor for the 20-month-olds (Mann-Whitney *U* tests, all *p*s ≥ .158, all *r*s ≤ .17).

Discussion

In this study, we investigated 14- and 20-month-olds' preference to look for and use information provided by an unfamiliar informant (the experimenter) and a familiar informant (the parent) in a hiding game. First, we could show that both infants at 14 and 20 months of age used the assistant's constant pointing gesture as an indicator for the location of a hidden object during the warm-up phases. This finding serves as a basis for infants' use of the constant

pointing gesture in the test phase, and it is in line with other studies demonstrating the ability to use the pointing gesture as a referential cue (Behne et al., 2005; Behne et al., 2012; Bretherton, 1991; Carpenter, Akhtar et al., 1998; Carpenter, Nagell et al., 1998; Woodward & Guajardo, 2002). The age-group comparison regarding infants' use of the pointing gesture did not reveal any differences. Therefore, this ability seems to be stable without significant improvement within infants' second year of life.

Infants' Looking Preference for the Unfamiliar Informant

The analyses of the test phase revealed that infants from both age groups preferred to look for information from the unfamiliar rather than the familiar informant. This finding is in line with findings reported in earlier social referencing studies (Stenberg, 2003, 2009; Stenberg & Hagekull, 2007; Walden & Kim, 2005). This preference even increased in terms of their first look at the informants from the first participation in the first half of their second year of life to the second participation in the second half of their second year of life. This developmental pathway is in line with the switch from newborns' preference of looking at familiar rather than unfamiliar faces (Bushneil et al., 1989; Field et al., 1984; Pascalis et al., 1995) to children's preference of looking at unfamiliar over familiar faces in ambiguous situations around their first birthdays (Stenberg, 2003, 2009; Stenberg & Hagekull, 2007; Walden & Kim, 2005). In these latter social referencing studies, infants experienced the experimenter's expertise concerning the laboratory location (see Stenberg, 2009; see also Study Set 1). These experiences of the experimenter as the local expert, the authors argue, led infants to ascribe knowledge about this situation and, thus, to predominantly look for information from the experimenter. However, we did not find any evidence to support the local-expertise hypothesis (see Study Set 1). Moreover, in our study, it was the assistant who expressed her/his local expertise by showing the parents how to get to the laboratory, and so on. Thus, given the operationalization of the person-context association in former studies, infants' looking preference for the experimenter in this study cannot be explained by this association. However, instead of a local-expertise hypothesis participants' looking preference for unfamiliar informants might rather be explained by an object-expertise hypothesis. Such an object-expertise hypothesis would assume that infants receive information from those informants more who are associated with the objects about which information was provided. In the current hiding-finding game, infants might associate the novel boxes and toys with the novel experimenter and thus ascribe more expertise about those objects to the experimenter than to their parent. To test such an object-expertise hypothesis is a challenge for future studies. Moreover, infants' looking behavior might also be interpreted as an informant-directed request to get the boxes that were out of infants' reach.

This alternative explanation could also be connected with the object-expertise hypothesis if infants wanted the experimenter to move the boxes into their reach based on her/his expertise about the apparatus. Moreover, we cannot rule out the possibility that infants' looking behavior – at least to some extent – was not driven by an ascription of knowledge but by the experimenters' novelty, since novelty does attract infants' attention (Fantz, 1964; Rose & Tamis-LeMonda, 1999). Testing this possibility is a task for future research. A more detailed discussion about these alternative explanations of infants' looking preference is presented in the General Discussion in this dissertation (section 4.3.1).

In the following we will present arguments supporting the interpretation of infants' looking behavior as looking for information. As done in social-referencing studies (Stenberg, 2003, 2009; Stenberg & Hagekull, 2007; Walden & Kim, 2005), we analyzed infants' looking behavior towards the unfamiliar and familiar informants after the assistant hid the toy and asked for its location as an indicator for infants' search for information. Across both age groups, that infants' first look was directed at the unfamiliar rather than the familiar informant can be interpreted as evidence for infants' preference to look for the experimenters' indication about the location of the hidden object. That is, this looking pattern might reflect their expectation that the unfamiliar informant will provide helpful information about the hidden objects' location. During the preceding eight warm-up trials, infants experienced that right after the question "Where is the thing?" they could choose a box to find the hidden object themselves. Thus, infants likely related this question with the possibility to search for the object. However, in the test phase, infants could not directly search for the object when the assistant asked this question. Here the boxes were still out of the infants' reach in this moment (see procedure). Thus, infants depended on others' information about the hidden objects' location. This is why we think that infants' first look at one of the two informants is good evidence for their search for information about the location of the hidden object. More evidence for this argument came from infants' looking time at the informants during this information search phase. Infants at both ages looked longer at the unfamiliar than at the familiar informant. This result might also reflect their expectation to receive information from an informant – preferably from the experimenter – since neither of the two informants provided any information about the object's location at this time. Additionally, infants at both ages showed more joint engagement with the unfamiliar informant than the familiar informant. This result on infants' joint engagement might provide the strongest evidence for our claim, because the number of gaze switches relates infants' looking behavior at the informants with the boxes and the assistant, that is, the area in which the hiding took place and the object was hidden. Finally, the sum of these three variables

together supports the interpretation of infants' looking behavior as their search for information about the hidden object's location. For a further discussion of possible reasons why infants preferably looked for information from the experimenter, see the Discussion of Study Set 1 (section 3.1.3) and the General Discussion (section 4.3.1).

Infants' Selective Information Use Depends on Infants' Age

In contrast to the strong preference in infants' gazing behavior, we could not find a similar preference for the infants' use of the unfamiliar informant's information in our study, neither at 14 nor at 20 months of age. Neither infants' gazing (first look at a box) nor grasping behavior (first touch of a box, first attempt to open a box) lead one to assume that infants differed in their use of information between the familiar and unfamiliar informant. Thus, although infants preferred to look for information from the unfamiliar informant, they did not use more information from this informant. This, however, does not mean that participants were not selective in their use of information in terms of the familiarity of the informants in general. Indeed, for the 14-month-old participants, significantly more infants were selective than infants who were non-selective in terms of the familiarity of informants when first attempting to open a box (i.e. infants first attempted to open the box indicated by the experimenter or the parent in at least 75% of trials). In contrast, the 20-month-old participants did not show a consistent effect of selectivity but were in equal parts selective and non-selective in terms of the familiarity of informants when first attempting to open a box (i.e. infants first attempted to open the box indicated by the experimenter or the parent in 50% of trials). Therefore, although there was no significant longitudinal difference in terms of the proportion of selective and non-selective participants, infants' information use at 14 months of age was significantly affected by the informants' familiarity, whereas at 20 months of age it clearly was not. One explanation for this might lie in the fact that both informants observed the hiding action and, thus, had a similar knowledge state about the objects' location. There was thus no rational reason to rely only on the information provided by one informant but not the other, and therefore, the informants' familiarity was not a relevant aspect to the solving of the problem in this study, that is, to find the hidden object. Therefore, our results might indicate a development of infants' social learning which could increasingly be characterized by rationality rather than aspects which are irrelevant (e.g. informants' familiarity in a hiding-finding game) coping with a concrete challenge. This assumption corresponds with the results reported in Study Set 2, which highlighted the development of taking an informant's knowledge state into account in a hiding-finding game within the second year of life (Study 2a). This development was further reflected in the finding that infants at 20 months of age but not at 14 months of age successfully used the informants'

knowledge states to search for a hidden object (Study 2b). Although a lot of studies gave evidence for infants' ability to take others' visual perspective – and therefore knowledge states – into account at the beginning of their second year of life (Brooks & Meltzoff, 2002; Liszkowski et al., 2008; Luo & Baillargeon, 2007; Poulin-Dubois et al., 2013; Sodian et al., 2007), it seems possible that younger infants are more vulnerable to irrelevant aspects than older infants who might be better at focusing on aspects more relevant to solving a problem. To what extent the informants' knowledge states indeed dominate their familiarity as a more relevant aspect in this paradigm should be investigated in future studies by incorporating a combined manipulation of both aspects into one experiment.

Limitations & Future Research

However, it is also possible that participants were confused by the two simultaneous suggestions which might have caused 20-month-olds' non-selectivity. When two suggestions were made at the same time, one suggestion had to be wrong. Thus, it is possible that participants decided to guess where to find the toy rather than to intentionally use one of the pointing gestures, resulting in an object-choice decision at chance level. However, there are two arguments supporting an interpretation of infants' behavior as the use of others' pointing cues. First, given infants' following of the assistant's indication in the warm-up phases, we have good reason to assume that infants' choice for one or the other box was influenced by the informants' pointing gesture in the test phase. Second, as emphasized before, approximately 2/3 of the 14-month-olds preferred to follow either the experimenter's or their parent's indication in at least 75% of trials, whereas only 1/3 of the participants at this age chose a box at chance level. Even for the 20-month-olds, the number of infants who were selective was equal to that of infants who were non-selective. Participants' performance in the test phase, therefore, was not dominated by a performance at chance level. Taken together, it is possible to interpret infants' behavior as the use of information rather than an independent and non-intentional choice at chance level. Nevertheless, one challenge for future research might be the extension of the paradigm we used in this study by offering participants more than two hiding locations. If they indeed intentionally used the experimenter's and the parent's information, one would expect them to prefer the locations indicated by the two informants and to neglect those locations that had not been indicated.

One might argue that the longitudinal design of the current study affected infants' performance based on possible learning effects. For example, we have to think about whether the pattern of selectivity that we have found for the 14-month-old but not the 20-month-old participants might be due to the infants' experiences during their initial participation. It is

possible that infants learned that a certain preference for the familiar or unfamiliar informant did not lead to a more efficient result when searching for the object in this hiding-finding game, which could have been reinforced by the closed boxes in the test phase. Consequently, infants might have remembered the irrelevance of being selective in terms of the informants' familiarity and, thus, more infants showed a non-selective pattern when searching for the object based on the informants' indications. However, in order to do so, infants had to remember the experiences of the first appointment until their second participation about 5 months later. Given the limited memory capacity of infants at this age (Rovee-Collier & Cuevas, 2009), it is questionable whether their behavior in the second appointment was indeed influenced by their prior experiences in the first appointment. Moreover, if there had indeed been a learning effect on infants in the second appointment, one would expect significant differences in infants' performance between their first and second instances of participation. However, our data did not provide evidence for such a learning effect because none of the age group comparisons resulted in a significant difference between infants' behavior in the first and second appointments.

When thinking about the limitations of the current study, one should take the broad age range of infants in the second appointment into account. As in the Discussion of Study Set 2 (see section 3.2.3), it is important to indicate that one has to be careful when interpreting the current results with respect to the precise age of infants. Therefore, we suggest, especially for infants in the second appointment, taking our data as evidence collected from a sample of infants in the second half of their second year of life.

A further challenge for future research might be the investigation of the gap we detected for both age groups in the current study. That is, while infants looked first and more at an unfamiliar informant than at a familiar one when lacking information about a situation, they did not show such a preference when it was their turn to use the information provided to them. In explaining this gap, it seems to be important to clarify infants' motivation of predominantly looking at the unfamiliar over the familiar informant (e.g. object-expertise hypothesis, novelty). Future research could benefit by adapting the crucial advantages in design and procedure the current study contained: Participants participated in a longitudinal study and were presented with a within-subjects design. Further, we were able to test a large number of participants, matched genders of familiar and unfamiliar informants, and faced a very small drop-out rate due to the highly motivating hiding-finding game.

Conclusion

To conclude, we discovered an interesting gab between information search (i.e. preference for the experimenter) and information use (i.e. no preference for a certain informant) of infants at both ages. Moreover, we detected that most of our participants at 14 months of age were nevertheless selective in terms of the informants' familiarity, meaning that most of them either preferred the familiar or the unfamiliar informant, whereas a significant fewer amount of infants had no preference. In contrast, infants at 20 months of age were not affected by the informants' familiarity – an aspect which was not relevant in order to solve the problem in the present paradigm. This finding raises a new assumption which has to be investigated in future studies, that is, infants at 14 months of age are more vulnerable to irrelevant cues than infants at 20 months of age, who might be better able to focus on aspects that are more relevant to solving a problem in social learning situations.

3.4 Study Set 4: The Quality of Parent-Infant Interaction

Following the results of Study 3, there was no preference for the familiar over the unfamiliar informant in terms of infants' information reception and use. This result was not in line with the hypothesized preference. A detailed look at the hypothesis concerning infants' preference for familiar over unfamiliar informants based on the various shared experiences infants had with familiar informants, however, refers to an underlying assumption of positive interaction experiences between the infant and her/his parent. However, as claimed in attachment theory, it is important to have positive experiences in everyday life interactions in order to develop a feeling of trust and secure attachment to the parent (Bowlby, 1969). The interaction experiences, in turn, are decisively dependent on the parents' acting and responses to their infants' signals. Until now, to the best of our knowledge, no study has investigated the correlations between the quality of parent-infant interaction – especially the parents' sensitivity to the infants' signals – and infants' selective preference for familiar versus unfamiliar informants. This question will be addressed in Study 4b and Study 4c. First, in Study 4a, we focus on the more general question whether parents' sensitivity is positively correlated with infants' reception and use of information provided by familiar and unfamiliar informants. For an overview of the manipulated variables (i.e. highlighted in green), the mediums and entities, as well as the infants' age, of Study Set 4, see Figure 30.

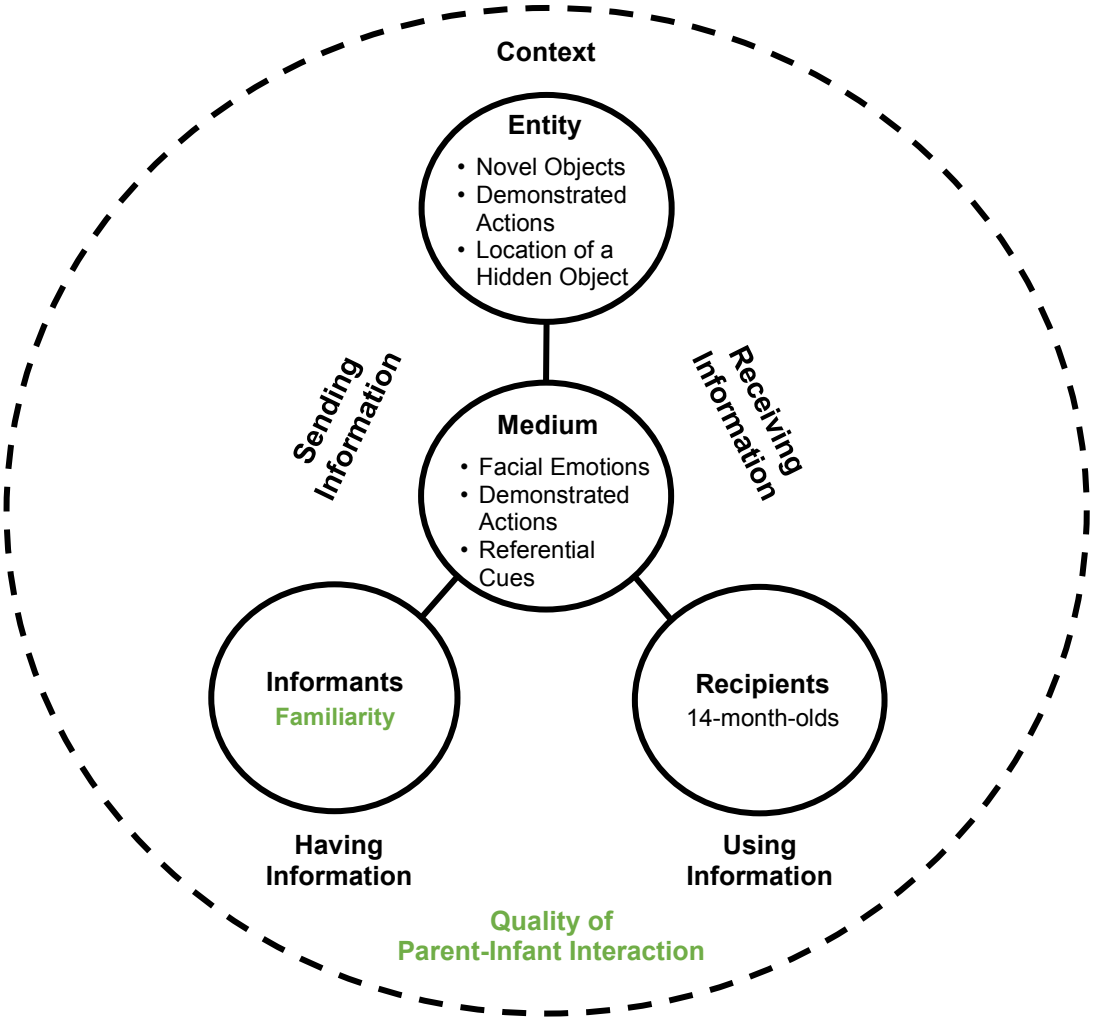

Figure 30. Overview of Study Set 4 based on the Organon model.

3.4.1 Study 4a: Parents' Sensitivity and Infants' Social Referencing

Some previous research has investigated infants' social referencing and exploratory behaviors when provided with information by familiar and unfamiliar interaction partners (e.g., Stenberg, 2009; Stenberg & Hagekull, 2007; Zarbatany & Lamb, 1985). However, no study has investigated the relationship between the quality of parent-infant interaction and infants' reception and use of information in such learning situations. The present study was designed to fill this gap. We re-analyzed the data of Study 1a in combination with data recorded in an independent play phase that took place before the actual experiment. From the videotapes we coded parents' behavior towards their infants and were, thus, able to check whether there was any transfer going on between the quality of familiar interactions and the infants' behavior in novel learning situations in which infants receive and use the provided information. Moreover,

we observed both the parent-infant interaction and the infants' performance in the exploration task in two locations, the laboratory and the infants' homes, which provides the possibility to generalize the results beyond the laboratory location. We expected those infants with more sensitive parents to receive more information from the informants and, hence, to act more appropriately (explore more when the box will be presented with positive emotions, explore less when the box will be presented with negative emotions) on the novel objects than infants with less sensitive parents. For an overview of the manipulated (i.e. highlighted in green) and measured components of Study 4a based on the Organon model, see Figure 31.

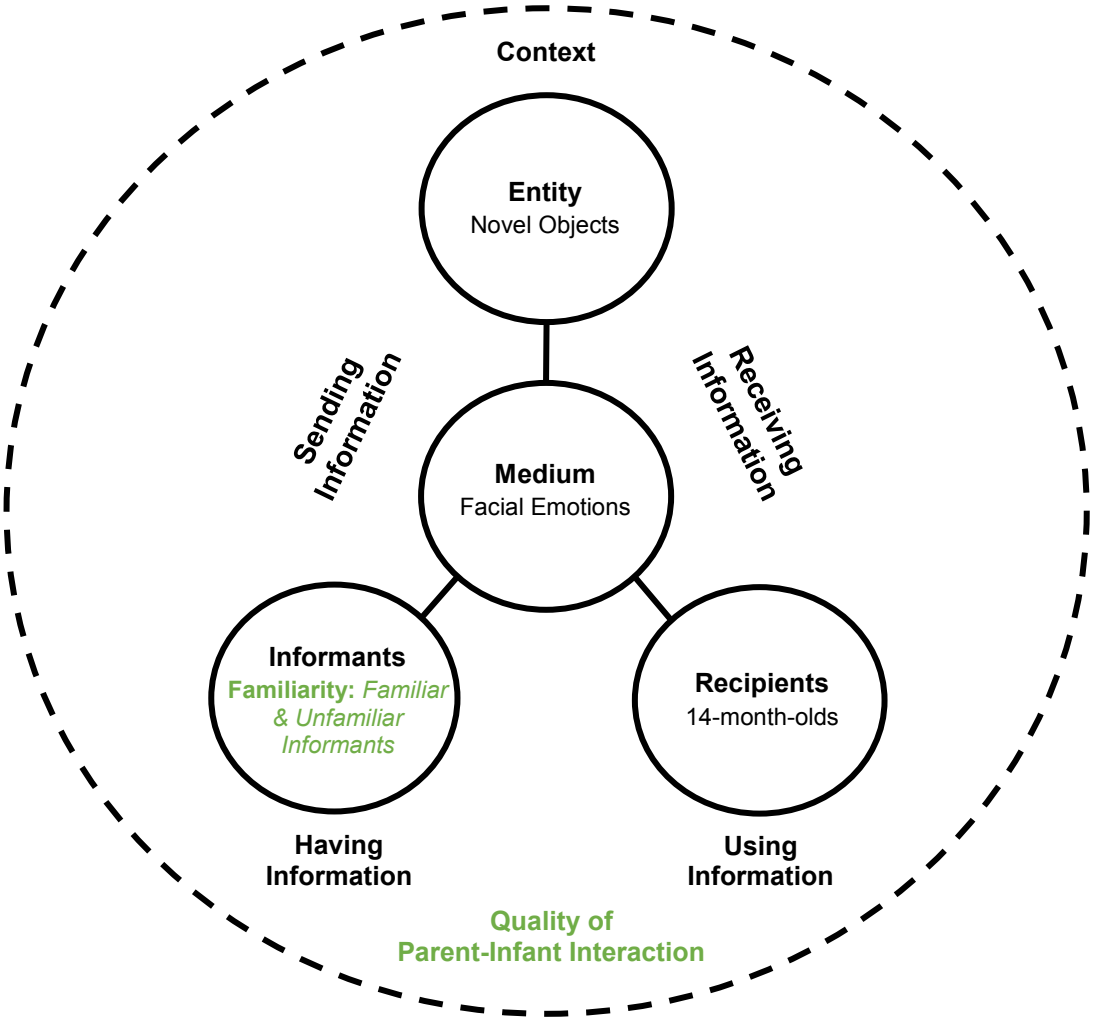

Figure 31. Overview of Study 4a based on the Organon model.

Method

Participants

78 14-month-olds (mean age = 13 months; 28 days, age range = 13;12 to 14;29, 40 females, 38 males) were included in the final sample. Additional infants were tested but had to be excluded from the analyses because they did not attend the second appointment (n = 6), or because of fussiness (n = 3), or because interactions were interrupted (n = 3). Half of the participants were tested in the laboratory, the other half at their homes[47]. The sample presented here was part of a larger sample (N = 137) whose data in the exploration task was reported in Study 1a (see section 3.1.1). Although all of their participants participated in a free-play phase at the beginning of the study, only the 90 participants reported here were comparable due to identical materials and instructions for the free-play phase. Participants were recruited from a database of parents who had agreed to participate in child development studies in a mid-sized German city. In addition to their general agreement, parents signed a consent form for participating at the current study prior to testing. Each infant received a toy and a certificate as gratification.

Apparatus and stimuli

In the free-play phase for parents and their infants participants were handed a set of toys (see Figure 32) including six little colored cups (from 5 to 7 cm in diameter), three toy animals (a dog, an elephant, and a polar bear, all approximately 10 x 7 x 3 cm), and a small picture book (8.5 x 8.5 cm, 8 pages). In the subsequent exploration task of Study 1a we used the novel exploration boxes, which contain different elements (e.g., bubble wrap) in order to investigate infants' exploratory behavior (see section 3.1.1).

[47] Since the difference in study location was not relevant for the current study, and we did not find any differences according to study location for any of our measurements (all ps ≥ .197, all rs ≤ .15), we will not focus on this issue in this study.

Figure 32. Study 4a: Interaction toys. The set of toys used in the observed free-play interaction between the parents and their infants (i.e. six little colored cups; a small picture book; and three toy animals: a polar bear, an elephant, and a dog).

Procedure

The Participants were tested in two appointments (1 week delay) either in the laboratory or at their homes (for methodological advantages of more than one observation and more than one context see Gardner, 2000). At each appointment, the study started with a warm-up phase in which the parent completed a consent form and the assistant played with the infant in a playroom. In the meantime, the experimenter explained the procedure to the parent without mentioning any hypotheses of the study. After this explanation, the parent was invited to play with her/his infant for 10 minutes in the playroom. We used toys in this play phase since joint play activities that include toys establish a good basis for joint attention situations (Bakeman & Adamson, 1984; Bronfenbrenner, 1979; Landry et al., 1998). Parents were asked to play with their infants as they usually did at home without any specific instructions except one: They were asked to make use of the little cups. We did this for two reasons: First, the instruction increased the comparability between the different parent-infant dyads because all of them used at least this toy. Second, the presence of such an instruction represented a challenge for the parents since they had to handle with a situation where at some point the task to use the cups conflicted with the infant's motivation to do so (like in everyday life where the parents need to combine the infant's interests with the everyday life requirements). A fixed camera in the playroom

videotaped the interaction free-play phase. Neither the experimenter nor the assistant were present during this, and no other interruptions took place. For an example of the object-based free-play observation of the parent-infant interaction, see Figure 33.

Figure 33. Study 4a: Parent-infant interaction. This figure exemplifies the observed parent-infant interaction. Each interaction observation was conducted on a green carpet with a certain set of toys (i.e. six little colored cups, three toy animals, and a small picture book).

After the free-play session both the parent and the experimenter went to the testing room and acted out the procedure of the exploration task while the assistant played with the infant in a playroom. Afterwards, the assistant and the infant entered the testing room and the social referencing task of Study 1a started (see section 3.1.1 for a description of the procedure). After the test phase, the experimenter, the assistant, the parent and the infant went back into the playroom and the experimenter explained the idea and hypotheses of the study to the parent.

Coding and Analyses

Interaction variables. According to previous research we analyzed three minutes of the free-play interaction between the parent and the infant for each session (six minutes in total) using an adapted version of the Maternal Affect Attunement Scale (MAAS, Bartling et al., 2010; Legerstee et al., 2007). This scale is based on the scales and subscales provided by Landry et al. (1998). Since the MAAS has not yet been evaluated for 14-month-olds thus far it is not recommended to make use of the coding scale in its original form used by Bartling et al. (2010), mainly because of the differing demands on parental sensitivity depending on the infant's age (Nicholls & Kirkland, 1996). Therefore, one important adaption was the adding of toys in the

free-play observation (see materials section) which made the free-play period more appropriate for this older age group compared to, for example, the 6- to 7-month-olds tested by Bartling et al. (2010). We coded the video sequences for the variables Maintaining Attention (MA) and Warm Sensitivity (WS) (see Legerstee et al., 2007). MA was coded whenever the parent "followed or maintained the infant's focus of attention by making a verbal or nonverbal response about the infants' object of attention" (Bartling, Kopp, & Lindenberger, 2010, p. 6). Thus, MA mainly represented the duration (in seconds) the parent attended and engaged in support of the infant's interests and objects of attention. For statistical analyses, we calculated percentage scores by dividing MA by the full length of observation time. The mean MA score was then built from both sessions.

The variable WS represented a score created out of the variables Positive Affect, Warm Concern, and Social Responsiveness. Positive Affect focused on the parent's affective behavior, the tone of voice, and the use of affective words (Bartling et al., 2010). For each minute, the coder rated those behaviors on a 1-to-5 Likert scale and the median of all minutes of both sessions was taken as the Positive Affect value included in the WS score. Warm Concern mainly targeted the parent's acceptance of infant activities, rated for each parental response to an infant behavior on a 1-to-5 scale ('1' = prohibition, '5' = support). The median was calculated for each minute and the overall median of all minutes of both sessions was taken as the Warm Concern value included in the WS score. We did not include the parent's concern for comfort and safety in Warm Concern (as did Bartling et al., 2010) since this behavior almost never appeared within the object-based free-play interaction in the current study. Finally, the variable Social Responsiveness referred to the parents' contingency that is whether they reacted to the infants' behavior within a time frame of 3 seconds. The reaction to every behavior of the infant was coded ('0' = no reaction within time frame, '1' =reaction within time frame), and the mean of all reactions was calculated for each minute. Then the overall mean of all minutes in both sessions was transformed to a 1-5 scale (0-0.1 = '1'; 0.2-0.3 = '2'; 0.4-0.5 = '3'; 0.6-0.7 = '4'; 0.8-1 = '5'). The transformed number was then included in the WS score as the Social Responsiveness value. Consequently, the WS score was the median of Positive Affect, Warm Concern, and Social Responsiveness, and represented an ordinal-scaled number between '1' and '5'.

Social referencing variables. See Study 1a (section 3.1.1) for a description of the coding and analyses of the variables we used in the social referencing task.

Data Reliability

To test the inter-rater reliability a naive coder who was blind to the hypotheses of the study coded 25% of the sample. Reliability for MA, WS and all subscales of the WS score (Positive Affect, Warm Concern, and Social Responsiveness) were done by calculating a two-way mixed model Intraclass-Correlation (ICC). The average measurement for MA was .963, $p < .001$, for Positive Affect it was .818, $p < .001$, for Warm Concern .756, $p < .001$, for Social Responsiveness .890, $p < .001$, and for the WS score it was .787, $p < .001$. These results are similar to those reported by Bartling et al. (2010). ICC for the inter-rater reliability of looking time was .983, $p < .001$, for the infants' looking at E, it was .973, $p < .001$, for the infants' looking at the parent, and it was .977, $p < .001$, for the infants' looking at the box. ICC for the inter-rater reliability of GS was .855, $p < .001$, for the gaze switches between the experimenter and the object, and it was .926, $p < .001$, for the gaze switches between the parent and the object. ICC for the exploration time was .985, $p < .001$, when the experimenter presented the box and it was .971, $p < .001$, when the parent presented the box. Non-parametric statistical tests were used whenever data did not comply with the conditions for parametric testing.

Results

Interaction

For the interval scaled MA score, parents maintained infants' attention in a mean of 63.8% of the interaction time (*Min* = 22.5% of time, *Max* = 99.2%, *SD* = 13.5). The coding of the three ordinal scaled variables which were integrated in the WS score resulted in the following subsequent data: Positive Affect (*Median* = 4, *Min* = 2, *Max* = 5, *SEM* = .09), Warm Concern (*Median* = 4, *Min* = 2.5, *Max* = 4.5, *SEM* = .05), Social Responsiveness (*Median* = 4, *Min* = 2, *Max* = 5, *SEM* = .08). For WS, parents reached a median score of 4 (*Min* = 2, *Max* = 5, *SEM* = .06). Moreover, all variables which were included in the WS score (Positive Affect, Warm Concern, Social Responsiveness) correlated positively with each other (all r_ss(78) ≥ .415, all *p*s ≤ .001). Finally, there was a positive correlation between both interaction scores MA and WS, $r_s(78) = .585$, $p \leq .001$. Given this high correlation and based on the fact that both interaction variables are expressions of the same core concept (i.e. concept of parental sensitivity, see Introduction, section 1.4.2), we split participants into a group of infants of parents who scored high in both MA and WS (*High-MAWS*, *n* = 34) and a group of infants of parents who scored low in both MA and WS (*Low-MAWS*, *n* = 25), based on median splits.

Looking behavior

Looking time at the informants. We conducted Spearman correlations to analyze the interrelation between the interaction variables and infants' looking time at the informants. First, we analyzed the average looking time at the experimenter and the parent without differentiating between positive and negative emotions. For when the experimenter presented the box, we found a small positive correlation between our measurements of MA and the looking time at the experimenter, $r_s(74) = .271$, $p = .018$, a medium positive correlation between the WS score and the looking time at the experimenter, $r_s(74) = .354$, $p = .002$, and a high positive correlation between MAWS and the looking time at the experimenter, $r_s(48) = .550$, $p < .001$. For when the parent presented the box, we found a medium positive correlation between the interaction score MA and the looking time at the parent, $r_s(61) = .352$, $p = .005$, a medium positive correlation between the WS score and the looking time at the parent, $r_s(61) = .413$, $p = .001$, and a medium positive correlation between MAWS and the looking time at the parent, $r_s(47) = .334$, $p = .022$. We further run the same analysis for the single emotions separately. For when the experimenter presented the box with positive emotions, there was no significant correlation for MA and the looking time at the experimenter, $r_s(74) = .208$, $p = .071$, however, the relation between WS and the looking time at the experimenter, $r_s(74) = .350$, $p = .002$, as well as between MAWS and the looking time at the experimenter, $r_s(57) = .334$, $p = .011$, resulted in a significant positive correlation. There were further significant correlations between both interaction scores and the looking time at the experimenter when the experimenter presented the box with negative emotions, MA: $r_s(75) = .259$, $p = .023$, WS: $r_s(75) = .267$, $p = .019$, MAWS: $r_s(58) = .308$, $p = .018$. Although we did not find any correlations between the two interaction scores separately and the looking time at the parent when the parent presented the box with positive emotions, MA: $r_s(70) = .173$, $p = .145$, WS: $r_s(70) = .173$, $p = .145$, we did so for MAWS, $r_s(54) = .300$, $p = .028$. Moreover, there were significant positive correlations between both interaction scores and the looking time at the parent when the parent resented the box with negative emotions, MA: $r_s(63) = .358$, $p = .003$, WS: $r_s(63) = .442$, $p < .001$, MAWS: $r_s(48) = .483$, $p = .001$. In summary, there were positive correlations between the interaction scores and infants' looking time at the social partners when a novel object was presented, in particular when the object was presented with negative emotions. Thus, infants of parents who scored high in MA and WS looked longer at the informant, irrespective of the informant's familiarity. See Figure 34 for a bar chart of these results.

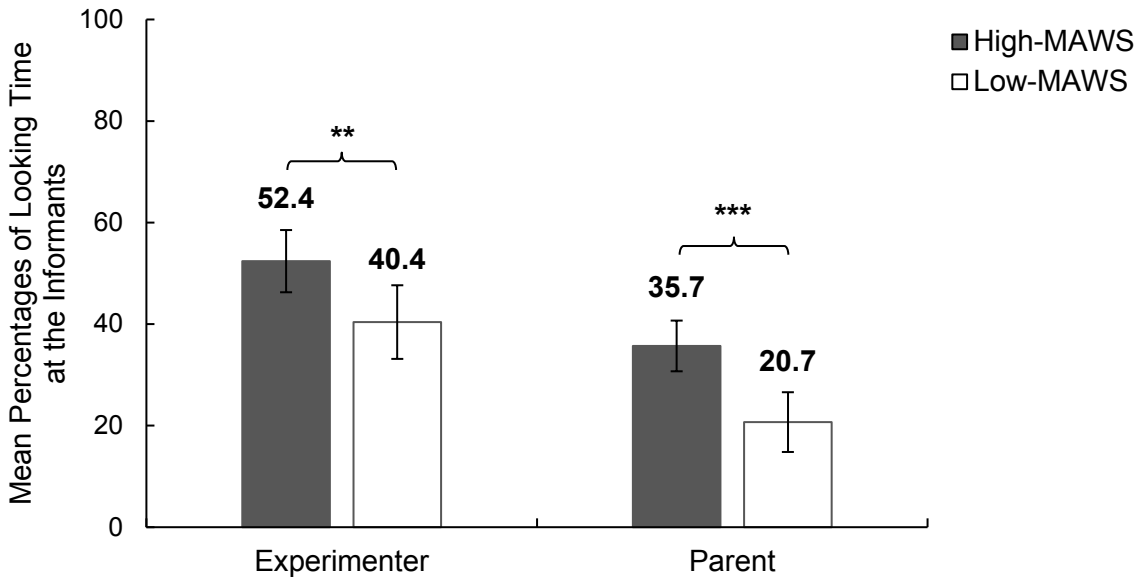

Figure 34. Study 4a: Bar chart of infants' looking time. The graph shows the mean percentages of time infants of parents with high scores in the interaction variables Maintaining Attention and Warm Sensitivity (*High-MAWS*) and infants of parents with low scores in the interaction variables Maintaining Attention and Warm Sensitivity (*Low-MAWS*) looked at both the experimenter and their parent. Significances are highlighted with asterisks based on Mann-Whitney *U* tests comparing the looking time the experimenter and their parent between both infants of the High-MAWS and the Low-MAWS group. Note: $^{**}p \leq .01$, $^{***}p \leq .001$. Error bars show 95% confidence intervals.

Looking time at the exploration boxes. The analysis regarding the interrelation between the interaction variables and the looking time at the exploration box during the presentation phase was conducted based on Spearman correlations and resulted in some negative correlations. For when the experimenter presented the box, there was no correlation for the interaction scores, MA: $r_s(74) = -.102$, $p = .382$, WS: $r_s(74) = -.192$, $p = .097$, MAWS: $r_s(57) = -.234$, $p = .080$. However, for when the parent presented the box, there was a significant negative correlation for both interaction scores, MA: $r_s(61) = -.256$, $p = .043$, WS: $r_s(61) = -.299$, $p = .017$, MAWS: $r_s(47) = -.403$, $p = .005$. We further run the analysis for the single emotions separately. There, no correlations were found for the interaction variables separately when the experimenter presented the box, MA: both $r_s(77) \leq -.182$, both $ps \geq .114$, WS: both $r_s(77) \leq -.206$, both $ps \geq .072$. For both interaction variables together, there was no correlation with infants' looking time at the boxes when the experimenter presented the box with positive emotions, MAWS: $r_s(57) = -.101$, $p = .454$, however, there was a negative correlation for when the experimenter presented the box with negative emotions, MAWS: $r_s(58) = -.283$, $p = .031$. Similarly, there were no correlations for when the parent presented the box with positive emotions, MA: $r_s(70) = -.024$, $p = .841$, WS: $r_s(70) = -.093$, $p = .436$, MAWS: $r_s(54) = -.155$, p

= .264, however, for when the parent displayed negative emotions we found a negative correlation between the interaction scores and the looking time at the boxes, MA: $r_s(63) = -.405$, $p = .001$, WS: $r_s(63) = -.445$, $p \leq .001$, MAWS: $r_s(48) = -.529$, $p < .001$. In summary, there were some negative correlations between the interaction scores and the looking time at the box, in particular when the experimenter and the parent presented the box with negative emotions.

Gaze Switches. We conducted further Spearman correlations to analyze the interrelation between the interaction variables and infants' gaze switches. Like for the looking time, we first analyzed the gaze switches for positive and negative emotions combined. Here, we found no correlations between the interaction scores and the gaze switches between the experimenter and the box for when the experimenter presented the box (all *p*s ≥ .103). However, for when the parent presented the box there was a positive correlation between MA as well as MAWS and the gaze switches gazes between the parent and the box, MA: $r_s(68) = .268$, $p = .025$, WS: $r_s(68) = .192$, $p = .111$, MAWS: $r_s(52) = .292$, $p = .035$. The analysis of the single emotions revealed a positive correlation between WS and the gaze switches between the experimenter and the box for when the experimenter presented the box with positive emotions, MA: $r_s(74) = .000$, $p = .999$, WS: $r_s(74) = .242$, $p = .036$, MAWS: $r_s(57) = .134$, $p = .321$, but no correlations between the interaction scores and the gaze switches between the experimenter and the box for when the experimenter presented the box with negative emotions (all *p*s ≥ .354). Similarly, for when the parent presented the box with positive emotions, we found positive correlations between the interaction scores and the gaze switches between the parent and the box, MA: $r_s(72) = .333$, $p = .004$, WS: $r_s(72) = .231$, $p = .048$, MAWS: $r_s(56) = .322$, $p = .015$. However, there were no correlations between the interaction scores and the gaze switches between the parent and the box for when the parent presented the box with negative emotions (all *p*s ≥ .188). In summary, there were some positive correlations between the infants' interaction scores and their gaze switches, particularly when the informants presented the box with positive emotions.

Exploratory behavior

The analyses of the interrelation between the interaction variables and infants' exploratory behavior was done based on Spearman correlations. None of the correlations resulted in any significant effect. Concerning the appropriate exploratory behavior (the exploration time for positive emotions minus the exploration time for negative emotions), no correlations with the interactions scores were found, neither for when the experimenter presented the box nor for when the parent presented it, MA: both $r_s(71) \leq .023$, both *p*s ≥ .852, WS: both $r_s(71) \leq -.154$, both *p*s ≥ .200, MAWS: both $r_s(54) \leq -.087$, both *ps* ≥ .531. No correlations were found either regarding the average of exploration time without differentiating between positive and negative

emotions, neither for when the experimenter presented the box nor for when the parent presented it, MA: both $r_s(71) \leq .186$, both $ps \geq .120$, WS: both $r_s(71) \leq -.076$, both $ps \geq .530$, MAWS: both $r_s(43) \leq -.096$, both $ps \geq .541$. With regard to the different emotions displayed by the two informants no correlations were found between the interaction scores and the exploration time, MA: all $ps \geq .217$, WS: all $ps \geq .075$, MAWS: all $ps \geq .584$. As a conclusion, infants' exploratory behavior was not related to the interaction scores. That means, infants of parents with higher interaction scores did not use more information than infants of parents with lower interaction scores.

Analyzing differences between groups of infants of parents with low and high interaction scores

We analyzed the differences between the group of infants of parents with high scores in both interaction variables (*High-MAWS*) and the group of infants of parents with low scores in both interaction variables (*Low-MAWS*) by conducting Mann-Whitney *U* tests. Given the significant correlations reported above, we focused on the analyses of infants' looking behavior. Infants in the *High-MAWS* group looked significantly longer at the experimenter when the experimenter presented the box than infants in the *Low-MAWS* group, $U = 229.000$, $p = .008$, $r = 0.35$. That means, infants in the *High-MAWS* group looked 12.0% of presentation time longer at the experimenter than infants in the *Low-MAWS* group did. Moreover, infants in the *High-MAWS* group also looked significantly longer at the parent when the parent presented the box than infants in the *Low-MAWS* group, $U = 100.000$, $p < .001$, $r = 0.49$. That means, infants in the *High-MAWS* group looked 15.0% of presentation time longer at the parent than infants in the *Low-MAWS* group did. Moreover, infants in the *Low-MAWS* group tended to look longer at the box presented by the experimenter than infants in the *High-MAWS* group, $U = 283.500$, $p = .080$, $r = 0.23$. Similarly, infants in the *Low-MAWS* group looked significantly longer at the box presented by the parent than infants in the *High-MAWS* group, $U = 136.000$, $p = .006$, $r = 0.40$. Moreover, when the experimenter presented the box, there was no difference between both groups concerning the gaze switches between the experimenter and the box, $U = 383.500$, $p = .903$, $r = 0.02$. However, infants in the *High-MAWS* group switched more gazes between the parent and the box than infants in the *Low-MAWS* group, $U = 217.500$, $p = .037$, $r = 0.29$. See Table 10 for an overview of the descriptive data and significances.

Table 10. *Study 4a: Descriptive statistics of infants' looking time. Mean percentages and standard deviations (in italics) of looking time at the informants; mean amount of gaze switches between the informants and the box; and mean percentages of looking time at the box when it was presented by the experimenter or the parent, reported for the group of infants of parents with high scores (High-MAWS) and the group of infants of parents with low scores (Low-MAWS) in the interaction variables Maintaining Attention and Warm Sensitivity.*

	Experimenter		**Parent**	
	High-MAWS	**Low-MAWS**	**High-MAWS**	**Low-MAWS**
	M	***M***	***M***	***M***
	SD	***SD***	***SD***	***SD***
Looking Time at the Informants	52.4**	40.4**	35.7***	20.7***
	17.3	*16.4*	*12.9*	*11.5*
Gaze Switches	5.3	5.1	6.0*	4.4*
	2.3	*1.7*	*2.9*	*2.4*
Looking Time at the Box	31.3	38.4	41.6**	53.4**
	10.6	*15.1*	*10.9*	*16.6*

Note. Differences between the High-MAWS and Low-MAWS group: $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$.

To conclude, the two interaction groups differed significantly in their looking time at the experimenter and at the parent. Infants of parents with higher scores in MA and WS looked longer at both the experimenter and the parent, and they switched more gazes between the parent and the box than infants of parents with lower scores in both interaction scores. However, infants' of parents with low interaction scores looked longer at the box when it was presented by the parent than infants of parents with high interaction scores.

Regression analysis

Given the consistent correlations between the interaction scores and infants' looking behavior, we ran linear regression analyses to check whether parents' sensitivity in the parent-infant interaction predicted a significant amount of variance in terms of infants' looking time at the informants, their gaze switches, and their looking time at the box during the presentation phase. As the predicting variable we included the binary variable MAWS that consisted of a group of infants of parents with high scores in the interaction variables MA and WS on the one hand, and another group of infants of parents with low scores in the interaction variables MA and WS (see this study, result section *Interaction*). The first regression analysis resulted in a significant prediction of 11.1% of the variance concerning infants' looking time at the experimenter, $R^2 = .111$, $F(1,55) = 6.860$, $p = .011$. Moreover, the regression analysis for infants' looking time at the parent resulted in a significant prediction of 26.3% of the variance, $R^2 = .263$, $F(1,45) = 16.046$, $p < .001$. For infants' gaze switches between the experimenter and the box the regression analysis revealed no predicting effect of MAWS, $R^2 = .001$, $F(1,55) = 0.064$, $p = .802$. However, the variable MAWS significantly predicted infants' gaze switches between the parent and the box with 8.9% of the variance, $R^2 = .089$, $F(1,50) = 4.866$, $p = .032$. Furthermore, infants' looking time at the box when the box was presented by the experimenter could be predicted with 7.2% of the variance by the variable MAWS, $R^2 = .072$, $F(1,55) = 4.269$, $p = .044$. Additionally, the variable MAWS predicted with 16.2% a significant amount of variance of infants' looking time at the box when the box was presented by the parent, $R^2 = .162$, $F(1,45) = 8.729$, $p = .005$. See Table 11 for a summary of the regression analyses.

Table 11. *Study 4a: Regression analyses. Summary of the linear regression analyses for predicting effects of the binary interaction variable MAWS on infants' looking time at the informants, infants' gaze switches between the informants and the box, and infants' looking time at the box when the experimenter or the parent presented the box.*

	Experimenter					**Parent**				
	B	***SE* (*B*)**	***β***	***t***	**Sig.**	***B***	***SE* (*B*)**	***β***	***t***	**Sig.**
Looking Time at the Informants	12.008	4.585	.33	2.619	.011	14.921	3.725	.51	4.006	.000
Gaze Switches	0.141	0.561	.03	0.252	.802	1.670	0.757	.23	2.206	.032
Looking Time at the Box	-7.020	3.397	-.27	-2.066	.044	-11.824	4.002	-.40	-2.955	.005

Control analyses

No gender differences were found for the interaction scores, neither for MA, Mann-Whitney $U = 687.50$, $N_{girls} = 40$, $N_{boys} = 38$, $p = .469$, $r = 0.08$, nor for WS, Mann-Whitney $U = 697.50$, $N_{girls} = 40$, $N_{boys} = 38$, $p = .494$, $r = 0.07$, or MAWS, Chi-square test, $\chi^2 = 0.272$, $N = 59$, $p = .791$. Concerning infants' looking time the control analyses for gender differences revealed different results for the separate measurements. For the looking time at the experimenter, females looked longer ($M = 51.2$, $SD = 19.4$) than males ($M = 44.9$, $SD = 14.2$), Mann-Whitney $U = 533.000$, $N_{girls} = 38$, $N_{boys} = 38$, $p = .050$, $r = 0.23$. There were no gender differences with respect to the looking time at the parent, Mann-Whitney $U = 370.00$, $N_{girls} = 29$, $N_{boys} = 34$, $p = .090$, $r = 0.21$, and the looking time at the exploration box, Mann-Whitney $U = 581.000$, $N_{girls} = 38$, $N_{boys} = 38$, $p = .143$, $r = 0.17$. Similarly, there were no gender effects for gaze switches between the experimenter and the box, Mann-Whitney $U = 657.50$, $N_{girls} = 38$, $N_{boys} = 38$, $p = .501$, $r = 0.08$, or for gaze switches between the parent and the box, Mann-Whitney $U = 504.00$, $N_{girls} = 34$, $N_{boys} = 36$, $p = .203$, $r = 0.02$. With respect to the exploration time, infants' gender did not affect their performance when the experimenter presented the box, Mann-Whitney $U = 604.00$, $N_{girls} = 36$, $N_{boys} = 35$, $p = .765$, $r = 0.04$, as well as when the parent presented the box, Mann-Whitney $U = 293.50$, $N_{girls} = 26$, $N_{boys} = 32$, $p = .055$, $r = 0.25$. There were no significant differences for any of the interaction measurements when the first and the second session were compared (Wilcoxon tests, all ps $\geq .066$, all rs $\leq .15$). Similarly, there were no differences between mothers ($n = 65$) and fathers ($n = 13$) as participants' interaction partners for any of the interaction measurements for neither of the test sessions (Mann-Whitney U tests, all ps $\geq .112$, all rs $\leq .21$).

Discussion

The aim of the current study was to investigate the interrelation between parents' sensitivity in the parent-infant interaction and infants' social referencing behavior. Our hypotheses were based on an assumption of mutuality. This means that we hypothesized that parents' sensitivity to infants' focus of attention and infants' interests in the common free-play was related to infants' reception of information provided by the informants – the more attention that parents pay to the infants' signals, the more attention infants pay to the parents' (and possibly others') signals. Accordingly, we hypothesized that infants would regulate their exploratory behavior more in accordance with the informants' emotional information (i.e. more exploration when positive emotions were displayed, less exploration when negative emotions were displayed) when parents' sensitivity in the parent-infant interaction was high – the more that parents

regulate their behavior in accordance with the infants' signals, the more infants regulate their behavior in accordance with the parents' (and possibly others') signals.

The current results support our hypothesis about the interrelation of parents' sensitivity and infants' reception of information provided by the informants. The higher parents scored in both interaction variables, the longer infants looked at both the familiar and the unfamiliar informant during the presentation phase. This positive correlation resulted in a significant difference between the group of infants of parents with high scores in both interaction variables and the group of infants of parents with low scores in both interaction variables. The linear regression analyses revealed that the binary variable, which represented a group of infants of parents with high scores in both interaction variables and a group of infants with low scores in both interaction variables, significantly predicted infants' looking time at both the familiar and unfamiliar informant. Unexpectedly, although we predicted a positive correlation between parents' sensitivity and infants' looking time at the novel object during the presentation phase, we found a negative correlation. That is, the higher parents scored in both interaction variables, the less amount of time infants looked at the boxes during the presentation phase. These correlations resulted in statistical differences between infants of parents with high interaction scores and infants of parents with low interaction scores, which was at trend level when the experimenter presented the box and was significant when the parent presented it. The corresponding regression analyses revealed significant predicting effects of the binary interaction variably on infants' looking time at the box both when the experimenter and when parent presented the box. Based on the increased looking time at the novel box, one could argue that infants of parents with low interaction scores perform better in social referencing tasks than infants of parents with high interaction scores. However, on the process of using others' information in order to evaluate a novel object, it is highly important for infants to pay visual attention to the informants' faces by which the emotional information about the object was provided. Only when infants recognize the informants' emotional expressions were they able to understand the meaning of the emotional message, such as a negative emotion that might advise infants to keep away from the novel object. However, without paying attention to the entity (i.e. the novel object) about which information was provided, infants were unlikely to be able to relate the emotional information about the novel object. Thus, in a social referencing situation it is not sufficient to look only at the informants or the object but rather to share the informants' focus of attention through joint engagement. Joint engagement is usually measured by the amount of gaze switches infants perform between an informant and the object (Carpenter, Nagell et al., 1998). We expected those infants of more sensitive parents to show more joint

engagement than infants of less sensitive parents. We found positive correlations between parents' interaction scores and infants' joint engagement, especially in terms of the parent. For infants' joint engagement with their parent, the correlation resulted in a significant difference between both interaction groups, and it resulted in a significant regression analysis, which indicated a predicting effect of parents' sensitivity. Thus, based on the results of infants' looking time at the informants and their joint engagement behavior, we conclude that parents' sensitivity was positively interrelated with infants' information reception from both familiar and unfamiliar informants in social referencing situations. This is a remarkable outcome of our study as it consequently emphasizes that the reported effects are not restricted to only a familiar informant – although the measurement of interaction quality only included this informant – but also occurred in terms of infants' information reception from unfamiliar informants.

However, for our second measurement of infants' information use, we did not find any correlations between parents' sensitivity in the parent-infant interaction and infants' exploratory behavior. Apparently, the effects we found for infants' information reception did not affect infants' behavior regulation when they acted on the novel objects subsequent to their information gathering during the presentation phase. One possible explanation for this effect might be that infants did not adjust their exploratory behavior to the displayed emotions in general (for possible explanations see Discussion of Study 1a, section 3.1.1).

Since many studies highlighted the importance of multi-contextual research as a necessary precondition for the generalization of the results (for a review see Gardner, 2000), we collected and analyzed our data in two different locations, the laboratory and the infants' homes. Given that there were no differences in the interaction scores between these two locations, as found in other studies as well (Borduin & Henggeler, 1981; Bornstein, Haynes, Legler, O'Reilly, & Painter, 1997), we analyzed the data for both locations together and are, consequently, able to generalize the results beyond the laboratory location.

Overall, we can conclude that certain aspects of the parent-infant interaction – the alignment of parents' sensitivity in terms of their active engagement based on the infants' focus of attention (Maintaining Attention), as well as in terms of their contingent, supportive, and warm reactions to the infants' signals and actions (Warm Sensitivity) – turned out to be crucial interrelating and predicting factors for infants' social referencing behavior. Thus, in order to reliably predict infants' information reception in social referencing situations based on the parents' sensitivity in the parent-infant interaction, one needs to consider at least the two measurements included in the current study. These results therefore highlight the importance of

parents' sensitivity in the parent-infant interaction for infants' social learning from various social partners.

3.4.2 Study 4b: Parents' Sensitivity and Infants' Imitative Behavior

In the present study, we observed the quality of parent-infant interaction in two free-play situations and correlated the coded interaction variables with infants' preference to receive and use more information provided by a familiar as opposed to an unfamiliar model[48] in an imitation task. In this task, both the familiar and the unfamiliar person modeled the same action resulting in exactly the same effect on an object (i.e., eliciting a sound) by using different tools. In this demonstration phase, we measured infants' looking behavior at the models to acquire knowledge about infants' preferences to receive information from familiar or unfamiliar models demonstrating a novel action on an object. Subsequently, infants were given the opportunity to imitate the action and we measured infants' tool choice to acquire knowledge about infants' preference for using information from familiar or unfamiliar models. Based on the claims of attachment theory and the importance of familiar informants for infants (see Introduction, section 1.3), we expected those infants of parents who scored high on the interaction variables Maintaining Attention and Warm Sensitivity to receive more information from the familiar model than from the unfamiliar model (i.e. looking at the models during their action demonstration) and, hence, to use more information from the familiar than the unfamiliar model (i.e. imitating the modeled actions). For an overview of the manipulated (i.e. highlighted in green) and measured components of Study 4b based on the Organon model, see Figure 35. As we have mentioned in Study 1b, the action demonstrated by the informants reflects both the medium by which and the entity about which the informants provide information in the imitation task.

[48] In the present study, we use the term *model* as equivalent to the term *informant*.

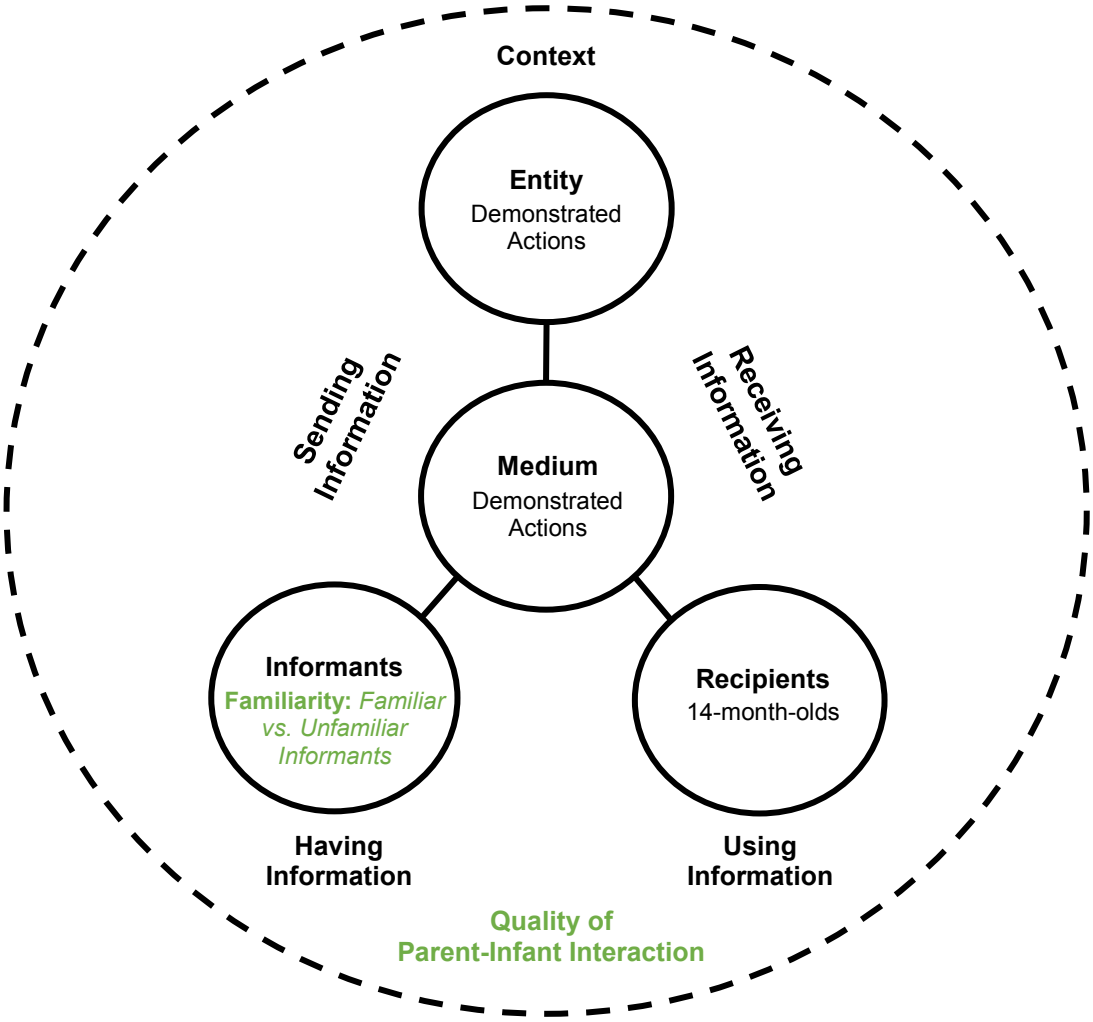

Figure 35. Overview of Study 4b based on the Organon model.

Method

Participants

78 14-month-olds (mean age = 13 months; 28 days, age range = 13;10 to 14;29, 40 females, 38 males) were included in the final sample. Additional infants were tested but had to be excluded from the analyses because they did not attend the second appointment (n = 5), or because of fussiness (n = 2), or because interactions were interrupted (n = 3). Approximately half of the participants were tested in the laboratory (n = 40), the other half were tested at their homes (n = 38)[49]. The sample presented here was part of a larger sample (N = 134) whose data

[49] Since the difference in study context was not relevant for the current study, and we did not find any differences according to study context for any of our measurements (all ps ≥ .197, all rs ≤ .15), we will not focus on this issue in this chapter.

in the imitation task was reported in Study 1b (see section 3.1.2). Although all of the participants participated in a free-play phase at the beginning of the study, only the 88 participants reported here were comparable due to identical materials and instructions for the free-play phase. Participants were recruited from a database of parents who had agreed to participate in child development studies in a mid-sized German city. In addition to their general agreement, parents signed a consent form for participating at the current study prior to testing. Each infant received a toy and a certificate as gratification.

Apparatus and stimuli

For a description of the toys that were used for the observation of the parent-infant interaction, see Study 4a (section 3.4.1). For a description of the materials we used in the subsequent imitation task, see Study 2b (section 3.2.2).

Procedure

For a detailed description of the set up and the procedure of the parent-infant interaction phase, see Study 4a (section 3.4.1). For a detailed description of the set up and the procedure of the imitation task, see Study 1b (section 3.1.2).

Coding and Analyses

For a detailed description of the coding and analyses of the variables we used to operationalize the parent-infant interaction, see Study 4a (section 3.4.1). For a detailed description of the coding and analyses of the variables we used in the imitation task, see Study 1b (section 3.1.2). In order to ensure that all trials were of identical presentation and modulation quality, we coded the experimenter's and the parent's performance. We excluded those trials in which the parent or the experimenter made at least one major mistake. As major mistakes we counted cases in which the presenters' emotions were not positive or her/his comments during the object presentation did not match the ones given (n = 3 trials)[50] or cases in which the model did not or not sufficiently elicit the effect with the tool (n = 9 trials). Another 11 trials had to be excluded due to infants' fussiness. Finally, 211 out of 234 possible trials could be analyzed.

Data reliability

For a description of the reliability of the coded interaction variables, see Study 4a (section 3.4.1). In order to assess inter-rater reliability for the imitation task, a naive research assistant, who was blind to the aims and hypotheses of the study, coded about 25% of the sample. By

[50] As reported above, although this manipulation was not the focus of our analyses, it is important that the models' presentations were of comparable quality.

using a two-way mixed model Intraclass-Correlation (ICC) for across all trials and Cohen's Kappa for the first trial, we found high correlations for all the variables for both types of analyses, across all trials (general use of the parent-tool: ICC = .978, $p < .001$, general use of the experimenter-tool: ICC = .946, $p < .001$; first use of the parent-tool: ICC = .979, $p < .001$; first use of the experimenter-tool: ICC = .939, $p < .001$) as well as for the first trial (general use of the parent-tool: $k = .926$, $p < .001$, general use of the experimenter-tool: $k = .841$, $p < .001$; first use: $k = 1.000$, $p < .001$).

Results

Interaction

The descriptive data of the variables coded for the parent-infant interaction were identical to the ones we reported in Study 4a. Thus, see section 3.4.1 for descriptive statistics of the interaction variables. Given the high correlation of both MA and WS, and based on the fact that both interaction variables are expressions of the same core concept (i.e. concept of parental sensitivity, see Introduction, section 1.4.2), we split participants into a group of infants of parents who scored high in both MA and WS (*High-MAWS*, $n = 34$) and a group of infants of parents who scored low in both MA and WS (*Low-MAWS*, $n = 25$), based on median splits.

Looking behavior

First, we analyzed possible correlations between the interaction variables and infants' looking behavior when the experimenter and the parent modeled the action based on Spearman correlations. Across all trials, there were no significant effects for none of the interaction variables, neither for infants' looking time at the models, MA: $r_s(78) = -.139$, $p = .248$, WS: $r_s(71) = -.110$, $p = .361$, MAWS: $r_s(54) = -.146$, $p = .291$, nor for their gaze switches between the models and the apparatus, MA: $r_s(65) = -.007$, $p = .954$, WS: $r_s(65) = -.039$, $p = .757$, MAWS: $r_s(50) = -.052$, $p = .720$. This pattern of results was the same when we analyzed the first trial separately: there were again no correlations for infants' looking time at the models, MA: $r_s(74) = -.090$, $p = .448$, WS: $r_s(74) = -.041$, $p = .731$, MAWS: $r_s(57) = -.022$, $p = .869$, and no correlations for their gaze switches between the models and the apparatus, MA: $r_s(74) = .020$, $p = .868$, WS: $r_s(74) = -.036$, $p = .760$, MAWS: $r_s(56) = -.062$, $p = .649$.

Imitative behavior

Second, we analyzed for correlations between the interaction variables and infants' imitative behavior of the previously modeled actions based on Spearman correlations. For this, we used preference scores of infants' imitative behavior (i.e. using the experimenter-tool minus using

the parent-tool). Across all trials, there were no significant effects for none of the interaction variables, neither for infants' general use of the tools, MA: $r_s(75) = -.033$, $p = .782$, WS: $r_s(75) = .053$, $p = .653$, MAWS: $r_s(57) = -.023$, $p = .863$, nor for their first use of a tool, MA: $r_s(75) = .017$, $p = .885$, WS: $r_s(75) = .163$, $p = .161$, MAWS: $r_s(57) = .118$, $p = .384$. When we analyzed the first trial separately, the same results occurred: there were no correlations for infants' general use of the tools, MA: $r_s(21) = .146$, $p = .528$, WS: $r_s(21) = -.270$, $p = .237$, MAWS: $r_s(17) = -.015$, $p = .953$, and no correlations for their first use of a tool, MA: $r_s(21) = .146$, $p = .528$, WS: $r_s(21) = -.270$, $p = .237$, MAWS: $r_s(17) = -.015$, $p = .953$.

Control analyses

No gender differences were found for the interaction scores (Mann-Whitney *U* tests, all *ps* ≥ .469, all *r*s ≤ .08). There were no significant differences for any of the interaction measurements when the first and the second session were compared (Wilcoxon tests, all *ps* ≥ .066, all *r*s ≤ .21). Similarly, there were no differences between mothers ($n = 65$) and fathers ($n = 13$) as participants' interaction partners for none of the interaction measurements in both test sessions (Mann-Whitney *U* tests, all *p*s ≥ .182, all *r*s ≤ .15). Moreover, we analyzed for differences between boys and girls in terms of infants' looking behavior in the imitation task. There, infants did not differ significantly concerning their gaze switches (Mann-Whitney *U* tests, all *p*s ≥ .077, all *r*s ≤ .22), however, regarding the difference scores we used in our analyses (looking time at the experimenter minus looking time at the parent), boys looked longer at the experimenter compared to their parent ($M = 2.5\%$ of modulation time, $SD = 3.6$) than did girls ($M = -0.1\%$ of modulation time, $SD = 4.2$), $U = 389.500$, $N_{boys} = 35$, $N_{girls} = 36$, $p = .006$, $r = 0.33$. This pattern occurred also in the first trial, there again boys looked longer at the experimenter compared to their parent ($M = 3.5\%$ of modulation time, $SD = 6.6$) than girls did ($M = 0.6\%$ of modulation time, $SD = 7.3$), $U = 486.500$, $N_{boys} = 36$, $N_{girls} = 38$, $p = .030$, $r = 0.25$. Regarding infants' imitative behavior, no gender differences were found, neither across all trials (Mann-Whitney *U* tests, all *p*s ≥ .217, all *r*s ≤ .14), nor for the first trial (Chi-Square tests, all *p*s ≥ .466). Since the experimenter was a male adult for all participants, we further analyzed whether there were differences for infants tested with their mothers (differently-gendered models, 63 infants) and infants tested with their fathers (same-gendered models, 12 infants). There were no significant differences between different-gendered and same-gendered models for none of the variables, neither for infants' looking behavior (Mann-Whitney *U* tests, all *p*s ≥ .743, all *r*s ≤ .04) nor for infants' imitative behavior (Mann-Whitney *U* tests, all *p*s ≥ .072, all *r*s ≤ .21).

Discussion

In this study, we investigated the interrelation of 14-month-olds' parent-infant interaction with their preference of receiving und using information provided by an unfamiliar model (the experimenter) as opposed to a familiar model (the parent) in an imitation task. We hypothesized that parents' sensitivity (i.e. Maintaining Attention and Warm Sensitivity) is positively correlated with infants' preference to receive and use information from their parents rather than the experimenter when they modeled an action on an object. However, we did not find any significant correlations between the interaction variables and infants' looking behavior nor their tool choice in the imitation experiment. Thus, infants' preferences for observing and imitating a modeled action from a familiar as opposed to an unfamiliar model did not correlate with the extent of the parents' engagement and sensitive reactions based on their infants' focus of attention and their infants' interests in the common free-play. It is possible that infants' performance in the imitation task complicates the possibility to find significant effects in the current study. A look at the first trial revealed that only some infants used any tool (33 out of 71 infants). Thus, this relatively low imitation rate automatically leads to a low amount of variance in the data of infants who imitated. This, in turn, makes it hard to indicate significant effects concerning infants' imitative preferences in correlation with parental sensitivity.

As a result, the level of parents' sensitivity in the interaction with their infants did not correlate with infants' preferences to observe and imitate an action modeled by a familiar as opposed to an unfamiliar model. Regarding the existent effects of other studies investigating the interrelation of parent-infant interaction and infants' selective social learning (Bono & Stifter, 2003; Landry et al., 1998; Legerstee et al., 2007; Varghese, 2007), we have to conclude that the kind of information matters (i.e. the medium, the entity). Thus, infants' selective social learning seems to be interrelated with the quality of parent-infant interaction in terms of emotional information as provided in social referencing situations. However, according to the present study, infants' selectivity when receiving information about and imitating a modeled action from a familiar versus an unfamiliar model does not seem to be interrelated with how sensitively parents interact with their infants.

3.4.3 Study 4c: Parents' Sensitivity and Infants' Object-Search Behavior

In the present study, we observed the quality of parent-infant interaction in a free-play situation and correlated the coded interaction variables with infants' preference to search for and use information provided by a familiar versus an unfamiliar informant in a hiding-finding game. For this, we manipulated the informants' familiarity within subjects and, thus, infants had to decide from which informant – the familiar versus the unfamiliar one – they looked for and used information about the location of a hidden object within each trial. We expected those infants of parents who scored high on the interaction variables – Maintaining Attention and Warm Sensitivity – to look for information from the familiar informant more than from the unfamiliar informant and, hence, to use more information from the familiar rather than the unfamiliar informant. For an overview of the manipulated (i.e. highlighted in green) and measured components of Study 4c based on the Organon model, see Figure 36.

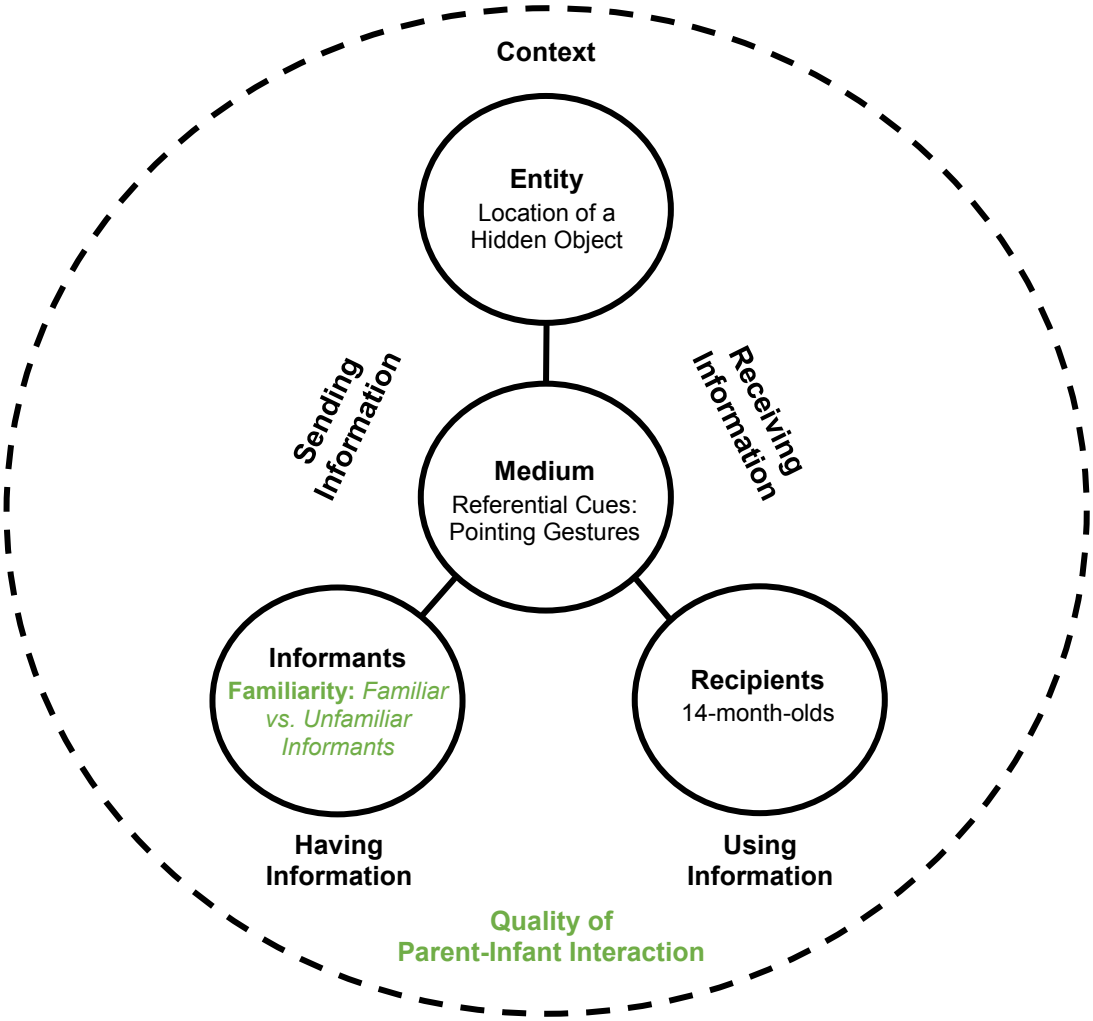

Figure 36. Overview of Study 4c based on the Organon model.

Method

Participants

The sample consisted of 97 infants at an age of 14 months (mean age = 13 months; 27 days, age range = 12;30 to 15;6, 48 females, 49 males). Three additional infants were tested but excluded from the analyses due to fussiness within the interaction observation (n = 2) or the hiding-finding game (n = 1). Participants were recruited from a database of parents who agreed to participate in child development studies in a mid-sized German city. Additionally to their general agreement, parents signed a consent form for participating in the current study prior to testing. Each infant received a toy and a certificate after participation.

Apparatus and stimuli

For a description of the toys that were used for the observation of the parent-infant interaction, see Study 4a (section 3.4.1). For a description of the materials we used in the subsequent hiding-finding game, see Study 3 (section 3.3).

Procedure

For a description of the set up and the procedure of the observation of the parent-infant interaction, see Study 4a (section 3.4.1). For a description of the set up and the procedure of the hiding-finding game, see Study 3 (section 3.3). Subsequent to the experiment, parents filled out two questionnaires: an adapted parenting-style questionnaire (Satow, 2013) to look for relationships with the observed parent-infant interaction and a questionnaire asking for their infants' temperament (Early Childhood Behavior Questionnaire, Putnam, Gartstein, & Rothbart, 2006) as a control variable for the measured quality of parent-infant interaction.

Coding and Analyses

For a description of the coding and analyses of the observation of the parent-infant interaction, see Study 4a (section 3.4.1). For a description of the coding and analyses of the variables we used in the hiding-finding game, see Study 3 (section 3.3). All analyses were conducted across all trials.

Data reliability

To test the inter-rater reliability of the interaction variables a naive coder who was blind to the hypotheses of the study coded 25% of the sample. Reliability for MA, WS and all subscales of the WS score were measured by calculating a two-way mixed model Intraclass-Correlation (ICC). The reliability analyses led to the following results: ICC for MA was .932, $p < .001$, for

the WS score it was .861, $p < .001$, for Positive Affect it was .814, $p < .001$, for Warm Concern it was .843, $p < .001$, and for Social Responsiveness it was .813, $p < .001$. These results are similar to those reported by Bartling et al. (2010).

In order to assess the inter-rater reliability for the variables of the hiding-finding game, a naive research assistant, who was blind to the aims and hypotheses of the study, coded 50% of the sample. The Intraclass-Correlation (ICC) for the inter-rater reliability was at least .912, $p < .001$, for all variables in the warm-up phase and it was at least .985, $p < .001$, for all variables of infants' information use in the test phase. ICC for infants' looking behavior in the test phase was at least .866, $p < .001$. In order to guarantee that all trials were of identical presentation quality we excluded those trials in which the assistant in the warm-up phases ($n = 4$ out of 800 trials), or the parent or the experimenter in the test phases ($n = 9$ out of 396 trials) did not provide their suggestions of the hidden toy as prescribed (i.e., verbal hint in combination with the maintained pointing gesture to the correct box). Moreover, we also excluded those trials ($n = 17$ out of 396 trials) in the test phase of infants' information search, in which any disruptive factors occurred (i.e., verbal comments or facial movements that could have influenced infants' looking behavior). The reliability for the presentation quality was coded for a quarter of the sample. It resulted in high correlations for both the warm-up phases (ICC = .913, $p < .001$) and the test phase (ICC = .947, $p < .001$).

Results

Warm-up phases

First, by conducting Wilcoxon tests we report the results in the warm-up phases to investigate whether infants were able to use the constant pointing gesture as referential cue for the location of the hidden object in this hiding-finding game. In the first warm-up phase, in which participants could see in which box the assistant hid the toy, we compared infants' first look at the indicated box as their looking response ($M = 75.0\%$ of trials, $SD = 23.8$) with chance level (50% of trials), resulting in a significant preference for looking first at the indicated box, $Z = -7.004$, $p < .001$, $r = 0.50$. In terms of infants' grasping response we found the same pattern. There, infants first touched the indicated box ($M = 77.8\%$ of trials, $SD = 22.5$) significantly more than expected by chance level, $Z = -7.332$, $p < .001$, $r = 0.53$. Moreover, infants first attempted to open the indicated box ($M = 78.7\%$ of trials, $SD = 22.0$) significantly more than expected by chance level, $Z = -7.480$, $p < .001$, $r = 0.54$, and infants also first opened the indicated box ($M = 77.8\%$ of trials, $SD = 22.6$) significantly more than expected by chance level, $Z = -7.330$, $p < .001$, $r = 0.53$.

In the second warm-up phase, we found the same pattern of results as we did in warm-up phase 1. We also compared infants' first look at the indicated box as their looking response (*M* = 71.9% of trials, *SD* = 23.9) with chance level, which resulted in a significant preference for the indicated box, $Z = -6.571$, $p < .001$, $r = 0.47$. Regarding participants' grasping response we found the following results: Infants first touched the indicated box (*M* = 71.8% of trials, *SD* = 24.1) significantly more than expected by chance level, $Z = -6.282$, $p < .001$, $r = 0.46$. Moreover, infants first attempted to open the indicated box (*M* = 71.6% of trials, *SD* = 24.5) significantly more than expected by chance level, $Z = -6.126$, $p < .001$, $r = 0.45$, and they first opened the indicated box (*M* = 71.6% of trials, *SD* = 24.4) significantly more than expected by chance level, $Z = -6.120$, $p < .001$, $r = 0.45$.

Interaction variables

For the MA score, parents maintained infants' attention at a duration of 62.8% of interaction time (*Min* = 8.3% of time, *Max* = 96.1%, *SD* = 18.0). The coding of the three variables which were integrated in the WS score resulted in the following data: Positive Affect (*Median* = 4.0, *Min* = 2.0, *Max* = 5.0, *SEM* = .08), Warm Concern (*Median* = 4.0, *Min* = 3.0, *Max* = 5.0, *SEM* = .06), and Social Responsiveness (*Median* = 4.0, *Min* = 1.0, *Max* = 5.0, *SEM* = .10). For the WS score, parents reached a median score of 4.0 (*Min* = 2.0, *Max* = 5.0, *SEM* = .06). Moreover, all variables which were included in the WS score (Positive Affect, Warm Concern, and Social Responsiveness) correlated positively with each other, Spearman correlation, all *r*s (97) ≥ .254, all *p*s ≤ .012. Finally, there was a positive correlation between both interaction scores MA and WS, Spearman correlation, r_s (97) = .382, $p < .001$. Given this correlation and based on the fact that both interaction variables are expressions of the same core concept (i.e. concept of parental sensitivity, see Introduction, section 1.4.2), we split participants into a group of infants of parents who scored high in both MA and WS (*High-MAWS*, *n* = 38) and a group of infants of parents who scored low in both MA and WS (*Low-MAWS*, *n* = 33), based on median splits.

Correlations between parent-infant interaction and infants' information reception

Based on Spearman correlations we analyzed whether the interaction scores MA and WS correlated with infants' looking behavior (difference scores for their first look, looking time, and gaze switches) at the informants in the hiding-finding game. When analyzing MA and WS separately, we did not find an effect between MA and infants' first look at the informants, $r_s(80) = -.145$, $p = .200$, but we did find an effect at trend level between WS and infants' first look at the informants, $r_s(80) = -.210$, $p = .061$, indicating that infants tended to look first at the parent than at the experimenter the higher their parents scored in the interaction variable WS. A similar

pattern was found for infants' looking time at the informants: Whereas no significant effect occurred between MA and infants' looking time at the informants, $r_s(80) = -.185$, $p = .101$, there was a significant correlation between WS and infants' looking time at the informants, $r_s(80) = -.256$, $p = .0.22$, indicating that infants looked longer at their parents than at the experimenter the higher their parents scored in the interaction variable WS. However, no correlations were found between the interaction variables and infants' gaze switches, MA: $r_s(80) = -.141$, $p = .212$, WS: $r_s(80) = -.183$, $p = .105$. Moreover, we further analyzed for correlations based on the binary variable MAWS. Although there was no correlation for infants' first look, $r_s(59) = -.190$, $p = .151$, and their gaze switches, $r_s(59) = -.201$, $p = .127$, there was a significant negative correlation for infants' looking time, $r_s(59) = -.262$, $p = .045$, indicating that infants looked longer at the familiar rather than the unfamiliar informant when their parents achieved high scores in both interaction variables MA and WS.

Correlations between parent-infant interaction and infants' information use

We checked whether the interaction scores MA and WS correlated separately with infants' first choice towards a box indicated by the familiar versus unfamiliar informant (i.e. first touch of a box, first attempt to open a box) by conducting Spearman correlations. Although there was no significant effect for infants' first touch of a box, MA: $r_s(84) = -.183$, $p = .096$, WS: $r_s(84) = -.129$, $p = .243$, we found a significant negative correlation between MA and infants preference to first attempt to open the box indicated by the familiar informant, MA: $r_s(83) = -.222$, $p = .043$, WS: $r_s(83) = -.143$, $p = .199$. That is, the higher parents scored in the interaction variable MA, the more infants preferred to first attempt to open the box indicated by the unfamiliar compared to the familiar informant. We found a similar pattern for the variable MAWS. There were significant negative correlations for both infants' first touch of a box, $r_s(61) = -.254$, $p = .049$, as well as for infants' first attempt to open a box, $r_s(61) = -.286$, $p = .025$, indicating that infants first attempted to open the box indicated by the unfamiliar compared to the familiar informant when their parents achieved high scores in both interaction variables.

Analyzing differences between groups of infants of parents with low and high interaction scores

Information search. Based on the correlative effects of infants' looking time at the informants, we compared the looking time of infants in the *High-MAWS* group with the performance of infants in the *Low-MAWS* group by conducting Mann-Whitney *U* tests. Results revealed a significant difference between both groups, $U = 302.500$, $p = .046$, $r = .26$, indicating that infants in the *High-MAWS* group looked longer at the familiar versus the unfamiliar informant (difference score: looking time at the unfamiliar informant minus looking time at the

familiar informant: *M* = 2.9% of looking time, *SD* = 13.7) compared to infants in the *Low-MAWS* group (difference score: looking time at the unfamiliar informant minus looking time at the familiar informant: *M* = 10.2% of time, *SD* = 12.8). This difference between both interaction groups is mainly due to the different looking time at the familiar informant, $U = 281.000$, $p = .020$, $r = .30$, meaning that infants in the *High-MAWS* group looked significantly longer at the familiar informant than infants in the *Low-MAWS* group did. The looking time at the unfamiliar informant did not differ between both interaction groups, $U = 371.000$, $p = .339$, $r = .12$.

Information use. Based on the correlative effects of infants' first touch of a box and their first attempt to open a box, we compared this variable between infants in the *High-MAWS* group and infants in the *Low-MAWS* group based on Mann-Whitney *U* tests. We found a significant difference between both groups for infants' first touch of a box, $U = 332.000$, $p = .050$, $r = .25$, illustrating that infants in the *High-MAWS* group first touched the box indicated by the unfamiliar versus the familiar informant (*M* = 50.3% of trials, *SD* = 27.5) more compared to infants in the *Low-MAWS* group (*M* = 37.8% of trials, *SD* = 29.1). Moreover, there was a significant difference between both groups for infants' first attempt to open a box, $U = 315.000$, $p = .027$, $r = .28$, indicating that infants in the *High-MAWS* group first attempted to open the box indicated by the unfamiliar versus the familiar informant (*M* = 52.7% of trials, *SD* = 27.0) more compared to infants in the *Low-MAWS* group (*M* = 37.5% of trials, *SD* = 30.6). For further descriptive statistics see Table 12.

Table 12. *Study 4c: Descriptive statistics for both interaction groups. Mean percentages and standard deviations (in italics) of trials in which infants with parents of high (High-MAWS) and low (Low-MAWS) scores in the variables Maintaining Attention and Warm Sensitivity first looked at the informants; mean percentages of time that infants looked at the informants (in seconds); mean amount of gazes that infants switched between the informants and the hiding area; and mean percentages of trials in which infants first looked at, first touched and first attempted to open a box indicated by the informants, are presented separately for the experimenter, the parent, and the difference score (experimenter minus parent; statistical significances are highlighted with asterisks) overall trials.*

	High-MAWS			**Low-MAWS**		
	Experimenter	**Parent**	**Experimenter – Parent**	**Experimenter**	**Parent**	**Experimenter – Parent**
	M	***M***	***M***	***M***	***M***	***M***
	SD	***SD***	***SD***	***SD***	***SD***	***SD***
First Look	48.7	51.3	-2.6	61.0*	39.0*	22.0
	32.5	*32.5*	*65.0*	*25.9*	*25.9*	*51.7*
Looking Time	18.1	15.2	2.9	20.8**	10.6**	10.2
	10.4	*7.6*	*1.4*	*11.6*	*5.0*	*12.8*
Gaze Switches	1.6	1.6	0.0	1.8*	1.4*	0.4
	1.0	*0.8*	*1.3*	*1.0*	*0.6*	*1.0*
First Touch of a Box	50.3	49.7	0.6	37.8	62.2	-24.4
	27.5	*27.5*	*55.0*	*29.1*	*29.1*	*58.2*
First Attempt to Open a Box	52.7	47.3	5.4	37.5	62.5	-25.0
	27.0	*27.0*	*54.0*	*30.6*	*30.6*	*61.2*

Note. Differences between both informants: $^{*}p \leq .05$, $^{**}p \leq .01$.

Separate analyses for infants of parents with low and high interaction scores

In this section we analyze infants' selective search for and use of information by conducting Wilcoxon tests for the two groups of *High-MAWS* and *Low-MAWS* separately.

Information search. The looking behavior of infants in the *High-MAWS* group did not differ between the familiar and unfamiliar informant in none of the variables (all *p*s ≥ .262, all *r*s ≤ .14). In contrast, the looking behavior of infants in the *Low-MAWS* group differed between the familiar and unfamiliar informant in terms of their first look, $Z = -2.220$, $p = .026$, $r = 0.30$, indicating that infants preferred to look first at the unfamiliar ($M = 61.0\%$ of trials, $SD = 25.9$) than the familiar informant ($M = 39.0\%$ of trials, $SD = 25.9$). Moreover, infants in the *Low-MAWS* group also differed in terms of their looking time at the informants, $Z = -3.347$, $p = .001$, $r = 0.45$, indicating that participants looked longer at the unfamiliar ($M = 20.8\%$ of time, $SD = 11.6$) than the familiar informant ($M = 10.6\%$ of trials, $SD = 5.0$). Moreover, infants in the *Low-MAWS* group differed in terms of their gaze switches, $Z = -2.063$, $p = .039$, $r = 0.28$, indicating that participants switched gazes more between the unfamiliar informant and the hiding area ($M = 1.8$ gaze switches, $SD = 1.0$) than between the familiar informant and the hiding area ($M = 1.4$ gaze switches, $SD = 0.6$).

Information use. The use of the informants' cues in the hiding-finding game did not differ between the familiar and unfamiliar informant for infants in the *High-MAWS* group in none of the variables (all *p*s ≥ .561, all *r*s ≤ .07). In contrast, the information use of infants in the *Low-MAWS* group differed at a trend level between the familiar and unfamiliar informant in terms of their first touch of a box, $Z = -1.943$, $p = .053$, $r = 0.35$, indicating that infants tended to first touch the box indicated by the familiar informant ($M = 62.2\%$ of trials, $SD = 29.1$) compared to chance level (50% of trials). Similarly, infants in the *Low-MAWS* group also tended to first attempt to open the box indicated by the familiar informant ($M = 62.5\%$ of trials, $SD = 30.6$) compared to chance level (50% of trials), $Z = -1.943$, $p = .053$, $r = 0.35$.

To investigate the general selectivity of infants in the *High-MAWS* group and the *Low-MAWS* group, we analyzed the frequencies of infants with a preference (i.e. infants first attempted to open the box indicated by the experimenter or the parent in at least 75% of trials) or without a preference (i.e. infants first attempted to open the box indicated by the experimenter or the parent in 50% of trials). Accordingly, for the *High-MAWS* group, 41.7% of infants ($n = 10$) did not show such a preference, whereas 58.3% of infants ($n = 14$) did. This difference between infants with and without a preference is not significant, Binomial-test, $N = 24$, $p = .541$. In contrast, for the *Low-MAWS* group, 30.0% of infants ($n = 9$) did not show such a preference, whereas 70.0% of infants ($n = 21$) did. This difference between infants with and

without a preference is statistically significant, Binomial-test, $N = 30$, $p = .043$. For a bar chart of this analysis, see Figure 37.

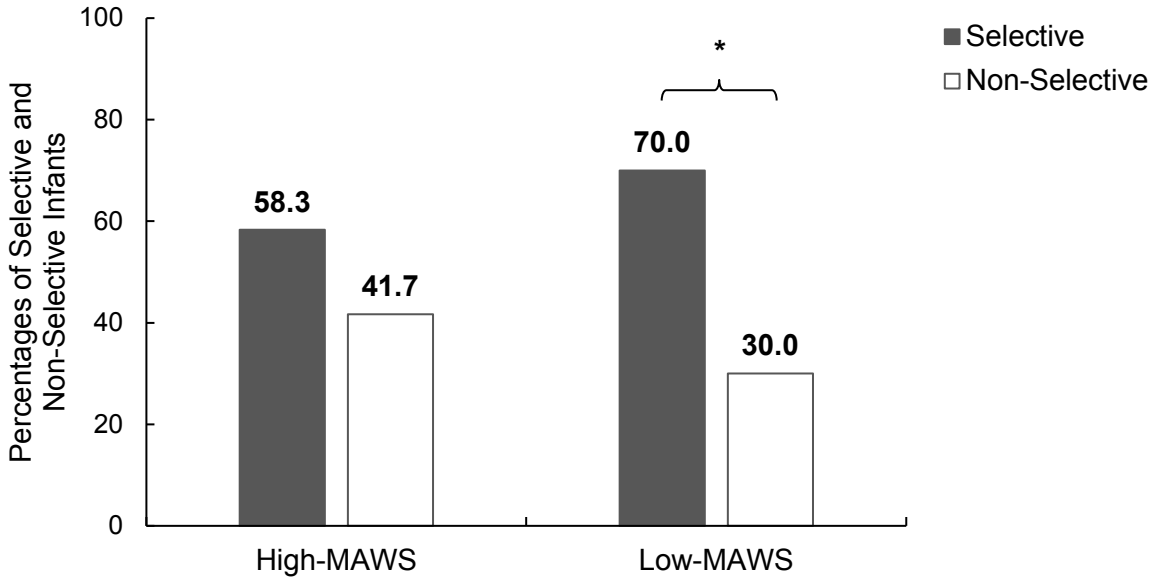

Figure 37. Study 4c: Bar chart of the selectivity of both interaction groups. The graph shows for infants of the *High-MAWS* group and infants of the *Low-MAWS* group separately the percentages of infants with a selective (i.e. infants first attempted to open the box indicated by the experimenter or the parent in at least 75% of trials) or a non-selective (i.e. infants first attempted to open the box indicated by the experimenter or the parent in 50% of trials) performance in the test phase. Significances are highlighted with asterisks based on Binomial tests comparing the number of selective and non-selective infants. Note: $^{*}p \leq .05$.

Regression analyses

Given the most consistent effects between the interaction variables and infants' preferences for the familiar versus unfamiliar informant in the hiding-finding game, we ran multiple regression analyses to check whether the parents' sensitivity predicted a significant amount of variance regarding infants' looking time at the informants, infants' first touch of a box as well as their first attempt to open a box. We included the dichotomous variable MAWS as the predicting variable. Moreover, we included the score of infants' effortful control as a control variable based on its correlative effects with the interaction variable WS (see *Control Analyses* of infants' temperament). The regression model for infants' looking time at the informants resulted in a significant effect: The variable MAWS predicted an additional amount of 8.9% of the variance of infants' looking preference, $R^2 = .090$, $R^2_{change} = .089$, $F_{change}(1,55) = 5.354$, $p_{change} = .024$. The regression model for infants' first touch of a box did not result in a significant effect ($p_{change} = .111$). However, the variable MAWS predicted an additional amount of 7.2% of

the variance of infants' first attempt to open a box, $R^2 = .079$, $R^2_{change} = .072$, $F_{change}(1,57) = 4.439$, $p_{change} = .040$.

Control Analyses

We checked for differences in infants' performance in the hiding-finding game between infants who were engaged in a free play interaction with their parents prior the experiment and infants who played with their parents after the experiment. No differences were found for none of the variables (Mann-Whitney *U* tests, all *p*s ≥ .288, all *r*s ≤ .17). Moreover, there were no differences between infants' gender, neither for the interaction variables (Mann-Whitney *U* tests, all *p*s ≥ .169, all *r*s ≤ .14), nor for the performance in the hiding-finding game (Mann-Whitney *U* tests, all *p*s ≥ .180, all *r*s ≤ .15). Furthermore, we investigated differences between the interaction scores of mothers and fathers. There, infants' mothers (*M* = 65.1% of time, *SD* = 18.1) scored significantly higher in the variable MA than did fathers (*M* = 57.2% of time, *SD* = 16.8), Mann-Whitney $U = 714.000$, $N_{mothers} = 69$, $N_{fathers} = 28$, $p = .045$, $r = 0.20$. However, although it was in the same direction, this effect was present only at trend level for the variable WS, Mann-Whitney $U = 743.500$, $N_{mothers} = 69$, $N_{fathers} = 28$, $p = .059$, $r = 0.19$. In addition, we checked for differences between infants who observed their mother as parent and a female experimenter and infants who observed their father as parent and a male experimenter. Since the parent and the experimenter always had the same gender we do not know whether differences were due to the parents' or the experimenter's gender. There were no differences for the warm-up phase (Mann-Whitney *U* tests, all *p*s ≥ .129, all *r*s ≤ .15), and also no differences for the test phase in terms of infants' looking behavior (Mann-Whitney *U* tests, all *p*s ≥ .058, all *r*s ≤ .21). However, infants first touched the box suggested by the parent more when the parent and the experimenter were male adults (*M* = 62.2% of trials, *SD* = 22.5) than when they were female adults (*M* = 50.9% of trials, *SD* = 29.7), Mann-Whitney $U = 554.500$, $N_{mothers} = 58$, $N_{fathers} = 26$, $p = .049$, $r = 0.22$. Similarly, infants first tried to open the box suggested by the parent more when the parent and the experimenter were male adults (*M* = 62.2% of trials, *SD* = 22.5) than when they were female adults (*M* = 49.7% of trials, *SD* = 30.3), Mann-Whitney $U = 529.000$, $N_{mothers} = 58$, $N_{fathers} = 26$, $p = .033$, $r = 0.23$. Moreover, we checked for differences between infants who saw at first the parent's suggestion and infants who saw at first the experimenter's suggestion in the first trial to check whether the informant who first provided infants with information had more influence on infant's choices than the informant who subsequently provided information about the hidden toy. There was no difference between these two groups (Mann-Whitney *U* tests, all *p*s ≥ .220, all *r*s ≤ .13).

For the analyses of the parent-infant interaction we controlled for infants' temperament based on a questionnaires for parents (see coding and analyses). There were no effects for the categories 'negative affect' (Spearman correlations, all r_ss(95) ≤ .098, all ps ≥ .344) and 'surgency' (Spearman correlations, all r_ss(95) ≤ .149, all ps ≥ .150). However, although there was no correlation for infants' 'effortful control' for the variable MA, Spearman correlation, $r_s(95) = .108$, $p = .298$, we found a positive correlation between 'effortful control' and the variable WS, Spearman correlation, $r_s(95) = .243$, $p = .018$. Finally, we wanted to investigate whether the observed parental behavior within the parent-infant interaction correlated with the statements that the parents made about their parenting style in the questionnaire (see coding and analyses). Although there was no effect concerning the variable MA, Spearman correlation, $r_s(95) = -.036$, $p = .732$, we found at least at trend level a positive correlation between the variable WS and the parents' statements about their responsiveness towards their infants' autonomy, Spearman correlation, $r_s(95) = .179$, $p = .083$.

Discussion

In this study, we investigated the interrelation between the quality of parent-infant interaction and 14-month-olds' preference to look for information from and to use information provided by an unfamiliar (the experimenter) versus a familiar informant (the parent) in a hiding-finding game. We hypothesized that parents' engagement – in relation to infants' focus of attention – and sensitive reactions positively correlated with infants' preference to look for and to use information from their parents rather than the experimenter in a hiding-finding game. The hiding-finding game investigated infants' preference for familiar versus unfamiliar informants and, thus, we were able to look for interrelations between this preference and the variables Maintaining Attention and Warm Sensitivity as expressions of parental sensitivity, which reflects an important aspect of the quality of parent-infant interaction. For the analyses, we combined both interaction variables by having one binary variable that consisted of a group of infants of parents with high scores in Maintaining Attention and Warm Sensitivity and the group of infants of parents with low scores. This combination can be well explained by their belonging to the same concept of parental sensitivity (see Introduction, section 1.4.2), and it is further supported by their positive correlation with each other.

For infants' information search we found significant correlations between infants' looking time at their parents compared to the experimenter with both interaction variables. This correlation indicates that the higher parents scored in both interaction variables, the more infants looked at their parents than at the experimenter. This effect also resulted in a significant difference between the group of infants of parents with high scores in Maintaining Attention

and Warm Sensitivity and the group of infants of parents with low scores in Maintaining Attention and Warm Sensitivity. Moreover, based on the multiple regression model, the combination of both variables predicted 8.9% of the variance of infants' looking preference across all trials. Thus, the more sensitively that parents reacted and the more that they were engaged based on their infants' focus of attention and infants' interests in the free play, the more that infants searched for information from their parents as opposed to the experimenter. Note, however, that this does not mean that infants of parents with higher scores in the interaction variables preferred to look longer at their parents than at the experimenter, but that the relation of looking at the informants changed in favor of the parent the higher parents scored in the interaction variables. A further look at the results, in which we conducted the analyses separately for the group of infants of parents with high scores in Maintaining Attention and Warm Sensitivity and the group of infants of parents with low scores in Maintaining Attention and Warm Sensitivity, helps to understand the meaning of this effect. The most consistent pattern of these analyses was that infants of parents with low scores differed between the two informants (i.e. preference of looking at the unfamiliar informant), whereas infants of parents with high scores did not. Accordingly, the less sensitively parents interacted with their infants, the less infants looked for information from their parents compared to the experimenter in such ambiguous situations. Moreover, the more sensitively that parents interacted with their infants, the more infants looked for information from both social partners available for gathering information.

For infants' information use, the variable Maintaining Attention and the variable representing infants of parents with low and high scores in both interaction variables correlated negatively with infants' first touch of a box and their first attempt to open a box. This demonstrates that the lower parents scored in both interaction variables, the more infants preferred to use the parents' cue over the experimenter's cue. The comparison of the two groups of high versus low interaction scores revealed a significant difference for both infants' first touch of a box and their first attempt to open a box. The corresponding multiple regression model revealed a significant predicting effect: Both interaction variables predicted 7.2% of the variance of infants' first attempt to open a box. In this regression model we controlled for infants' temperament (i.e. effortful control). These effects of infants' information use demonstrate that infants of parents with low scores in both interaction variables used the parents' information more than the experimenter's information for their spontaneous choice when searching for the hidden toy than did infants of parents with high scores in both interaction variables. However, as we noticed when discussing the effects of information search, this result

does not necessarily mean that infants of parents with high interaction scores preferred to use the parents' indications over those of the experimenter. A look at the separate analyses clarifies this pattern of result. In these analyses and similar to the findings of infants' information search, the most consistent effect was that infants of parents with high interaction scores usually did not differ between familiar and unfamiliar informants and were not selective in terms of the informants' familiarity at all. Alternatively, infants of parents with low scores were generally selective in terms of the informants' familiarity and they differed at a trend level between both informants by preferring the familiar informant's cues over those of the unfamiliar informant. This is interesting, since we predicted a positive correlation between parents' scores in the interaction variables and infants' use of their parents' information about the location of the hidden toy. However, a plausible interpretation of the current results might be that the more sensitively parents interacted with their infants, the less restricted infants were to the parents' cues. Rather, infants were sensitive and ready to make use of both the familiar and the unfamiliar informants' information. This is reasonable with respect to the hiding-finding game in which both informants had the same knowledge about the hidden objects' location (since both paid attention to the hiding of the object) and, thus, were equally reliable sources of information and relevant for infants to solve their problem (i.e. finding the hidden object). Thus, parents' increased sensitivity possibly was related to infants' increased sensitivity to the knowledge state of both informants. This sensitivity of infants, in turn, could have enabled a more rational use of informants in their social environment that was reflected by the similar use of information provided by the similar knowledgeable social partners in the hiding-finding game. Understanding the data in this way would correspond to one of our hypotheses – and even extend it – that the more that the parents take their infants' signals into account, the more infants are willing and able to take the signals and circumstances in their social environment into account. This increased awareness regarding their social environment including such mental-state-related features of social partners (e.g. visual perspective, knowledge state) refers to studies that claim correlations between parents' sensitivity in terms of mind-mindedness and infants' ability of theory of mind (Meins et al., 2002; Meins et al., 2003). However, whether the measured interaction variables indeed correlate with infants' ability to track others' mental states reflects an extension of our original hypothesis and should be tested in further studies.

Our finding of the increased influence of an informants' familiarity on infants of less sensitive parents, although the informants' familiarity was irrelevant for infants' problem-solving, corresponds with the results reported by Corriveau and Harris (2009). In their study, only the secure attached participants (50- and 61-month-old children) appropriately evaluated

the trustworthiness of their parent and a stranger based on available perceptual cues (see section 1.3.2, for a more detailed description of the study). Moreover, our results are in line with the theoretical assumptions that arise from attachment theory (Ainsworth et al., 1978; Bowlby, 1969) and studies about the effects of the quality of parent-infant interaction on infants' social and cognitive development (Aschersleben, 2008; Bartling et al., 2010; Belsky et al., 1991; Bono & Stifter, 2003; Bornstein & Tamis-LeMonda, 1989; Goldberg et al., 1989; Hofer, Hohenberger, Hauf, & Aschersleben, 2008; Landry et al., 1996; Landry et al., 1998; Legerstee et al., 2007; Lewis & Goldberg, 1969; MacDonald, 1992; Parpal & Maccoby, 1985; Schneider, 2010). Both attachment theory as well as the empirical studies claim infants' increased attention, curiosity and confidence when exploring their physical and social environment. This, in turn, is mainly based on infants' experience of sensitive interactions with their parents, which serve as a secure base for infants and their development. The increase of attention, curiosity and confidence when solving a problem might have supported infants to discover and focus on the relevant aspects, which in the current study is the informants' knowledge about the location of the hidden object rather than the informants' familiarity.

In the following we would like to discuss the pattern of selectivity of infants of less sensitive parents, that is, their preference for the unfamiliar over the familiar informant when looking for information and, in contrast, their tendency to use their parents' information over that of the unfamiliar informant. First, their looking preference for unfamiliar informants might be explained by the relatively low expectations that those infants developed based on the parent-infant interaction about their parents as reliable sources of information. This, in turn, corresponds with our hypothesis of mutuality, that is, the more that parents take their infants' signals into account, the more infants are willing to take their parents' signals and information into account. Second, their tendency to use their parents' information over that of the unfamiliar informant emphasizes that infants' preference for the unfamiliar informant when looking for information did not result in their use of this informant's information. This difference could be caused by the difference between mere looking behavior and the use of others' information, which leads to behavioral consequences for infants. The decision to regulate their own behavior in accordance with an unfamiliar experimenter to some extent requires the confidence to trust strangers. Based on the assumptions of attachment theory and the empirical evidence of the effects of the quality of parent-infant interaction and especially the parental sensitivity mentioned in the previous section, one could assume a lack of such a confidence for infants with less sensitive parents. This might have resulted in infants' tendency to avoid the experimenter's suggestion. In our paradigm, to neglect the experimenter's information

automatically leads to the use of the parents' information when infants decided to choose a box. In the end, this could have accounted for infants' tendency to use their parents' information over that of the experimenter.

Note that in the present study one has to be careful with the use of our data to demonstrate infants' use of others' information in the comparable instances of first touching a box or first attempting to open a box because the same results would have occurred if infants used no information at all but rather searched for the toy on their own at chance level. However, as discussed in a former study (see Discussion of Study 3), participants made use of the pointing gesture in the warm-up phases and, moreover, participants' performance in the test phase was not dominated by a performance at chance level, leading to an interpretation of infants' behavior as the use of information rather than an independent and unintentional choice at chance level. Moreover, although infants' looking behavior at informants can be interpreted in other ways than information seeking (such as looking to engage with others; for a discussion of other interpretations of infants' looking behavior see section 4.3.1), we think that there is good reason to take this data as evidence for infants' information gathering. Infants' looking behavior was measured after the assistant hid the toy and asked for its location. In the preceding warm-up trials infants experienced that directly after the question "Where is the thing?" they could choose a box to find the object. Therefore, infants likely related this question to the chance to search for the object. However, in the test phase infants could not search for the object right after the assistant asked "Where is the thing?" because the boxes were still out of the infants' reach (see procedure). Thus, infants depended on others' information about the hidden objects' location – since they could not search for it on their own – and by looking at the informants, they were able to express their motivation or expectation to receive information about the objects' location.

In our control analyses, we did not find any significant correlations between the observed interaction scores and parents' statements about their parenting style concerning their infants' autonomy. However, there was at least an effect at trend level for the variable Warm Sensitivity, which can cautiously be taken as evidence for the observed interaction quality as a trait rather than a state. The missing significant correlations might be due to different methods of measuring parental interactive behavior (i.e. questionnaire versus observation). Moreover, it is possible that one measurement was more vulnerable to certain disruptive factors than the other (e.g., social desirability, see Moorman & Podsakoff, 1992, for a review). For example, one can imagine that it is easier to give socially desirable answers in a questionnaire than to decidedly adjust one's own interactive style for both verbal and non-verbal behavior.

In conclusion, our results indicate that the more sensitively parents reacted to their infants' focus of attention and infants' interests during common play, the less infants' information search and use was affected by informants' familiarity – an aspect which was not relevant to finding the object and thus to solving the problem in this hiding-finding game. Therefore, infants of more sensitive parents might predominantly take more relevant aspects into account when solving problems by social learning (i.e. informants' knowledge states), reflecting infants' increased sensitivity when evaluating their parents and others as reliable sources of information. This claim of the current study should be investigated in future research.

3.4.4 Discussion of Study Set 4

The aim of Study Set 4 was to investigate the relationship between the quality of parent-infant interaction and infants' social learning and its selectivity concerning familiar versus unfamiliar informants. The studies provide evidence for such a relationship highlighting the importance of parents' sensitivity in parent-infant interaction for infants' social learning and its selectivity. In all studies the parents' sensitivity was measured in terms of their active engagement based on the infants' focus of attention (Maintaining Attention), as well as in terms of their contingent, supportive, and warm reactions to the infants' signals and actions (Warm Sensitivity).

A Summary of the Results of Study Set 4

In Study 4a, infants' reception and use of emotional information provided from both a familiar and an unfamiliar informant were investigated in a social referencing paradigm. We found positive correlations between parents' sensitivity and infants' information reception from the informants. This correlation resulted in significant differences between infants of parents who scored high in both interaction variables and infants of parent who scored low in both interaction variables. As revealed by the regression analyses, parents' sensitivity in the parent-infant interaction predicted a significant amount of variance of infants' information reception. Remarkably, this effect occurred for both the familiar as well as the unfamiliar informant. No effect was found for infants' information use. Thus, parents' sensitivity was positively interrelated with infants' information reception from both informants in a social referencing situation. In Study 4b, both a familiar and an unfamiliar informant provided infants with information about a modeled action within each trial of an imitation paradigm. In this study, no correlations between parents' sensitivity and infants' behavior in the imitation paradigm were found, neither for infants' information reception, nor for their information use reflected by their

imitative behavior. Thus, when observing and imitating novel actions modeled by adults, infants' selectivity for familiar or unfamiliar informants was not related to parents' sensitivity. In Study 4c, in which again both a familiar and an unfamiliar informant provided information within each trial of a hiding-finding game, we found different pattern of selectivity for infants of parents who scored high in both interaction variables and infants of parents who scored low in both interaction variables. Whereas infants of more sensitive parents did not differ between a familiar and an unfamiliar informant, infants of less sensitive parents did. This indicates that the more sensitively parents reacted to their infants' focus of attention and infants' interests within the common play, the less infants' information search and use was affected by informants' familiarity. Interestingly, the familiarity of informants was not relevant to find the object and thus to solve the problem in this hiding-finding game. Therefore, infants of more sensitive parents might be better prepared to focus on the relevant aspects when solving problems through social learning (i.e. informants' knowledge states). This might reflect an increased sensitivity of infants with more sensitive parents when evaluating their parents and others as reliable sources of information.

Different Effects as a Result of Different Paradigms?

In a detailed look at the effects, a lack of uniformity of the effects across the studies must be stated. For example, although Study 4c provided significant effects between parents' sensitivity and infants' selectivity when receiving and using information from familiar and unfamiliar informants, infants' selective information reception and imitative behavior was not related to parents' sensitivity in Study 4b. Thus, it seems important to take a look at the different paradigms that we used to investigate these interrelations. In the imitation task of Study 4b, infants' looking behavior at the informants was measured during the informants' modulation of the novel action. The informants' action on the object, which elicited a sound effect by using the tool, likely distracted infants' attention from the informants' faces to the object. This interpretation is supported by infants' looking time during the modulation phase, indicating a mean looking time at the modeled action of about 90% of modulation time. Thus, infants were not very interested in informants' faces during this task, possibly explaining the lack of significant effects concerning infants' visual attention to the informants. In contrast, infants' visual attention to the informants' emotional expressions did not distract infants from looking at the informants in Study 4a, because infants' looking at the facial emotions as information was identical to infants' looking at the informants' faces. This increased amount of looking time at the informants (mean looking time of about 1/3 of presentation time) likely facilitates the discovery of statistical significant effects. Similarly, infants' looking behavior in Study 4c was

also not distracted by any informants' action, in that we included a separate phase in which infants could look at the informants for information.

It is possible that task specificity also accounts for the lack of significant results between parents' sensitivity and infants' imitative behavior. In the imitation task of Study 4b, it was obvious that both tools led to the same sound effect, which could have decreased the relevance for infants to imitate selectively by using only the tool from the familiar or unfamiliar informant. Similarly, given the lack of significant effects between parents' sensitivity and infants' exploratory behavior in the social referencing task of Study 4a, infants possibly perceived no reason to rely more on the emotions of the familiar informant than on those of the unfamiliar informant when evaluating the valence of the novel object. These differences in the method between the single paradigms possibly account, at least to some extent, for the different findings, suggesting that the results should be interpreted in the light of the task that was used.

Limitations

When thinking about the limitations of the current studies, we would like to point out the presence of apparent small effect sizes. One possible reason for this might lie in the short amount of time of interaction observation (i.e. 3 minutes in each of the two appointments in Study 4a and Study 4b, 3 minutes in Study 4c). Thus, the interaction observations can only represent an extract of infants' every day experiences when interacting with their parents in common play. However, other studies also report significant effects by using similar durations when observing the quality of parent-infant interaction (Bartling et al., 2010; Keller et al., 2004; Keller, Lohaus, Volker, Cappenberg, & Chasiotis, 1999; Legerstee et al., 2007; Lohaus, Keller, Ball, Voelker, & Elben, 2004). Moreover, by measuring specific parental behaviors (i.e. parents' sensitivity), we only focused on certain aspects of the quality of parent-infant interaction. Consequently, our data cannot represent the richness of the quality of parent-infant interaction, which might additionally shape infants' social learning behavior. Furthermore, in that the participation of parents was voluntary, it is possible that those participating parents were especially motivated to contribute to the empirical infant research and, thus, were particularly motivated to ensure infants' wellbeing in the common free-play observation. This, in turn, could have increased their engagement and sensitive responses to infants' signals, which is possibly supported by relatively high median scores in the interaction variables (Maintaining Attention: 62.8% out of 100%; Warm Sensitivity: 4 out of 5). Thus, the scarcity of very low scores in both interaction variables could represent, to some extent, a challenge for obtaining large effects in the corresponding analyses. Given the limitations discussed here, the discovery of the significant effects reported above, which were consistent in their direction and reliable across

different analyses within each paradigm, remains remarkable. This could inspire future research to further investigate the interrelations between parent-infant interaction and infants' selective social learning.

The cross-sectional investigation of the effects between the quality of parent-infant interaction and infants' social learning allows us to report significant interrelations. However, because we did not adapt a longitudinal design for this research question, the results cannot be interpreted as directed effects of the interaction quality on infants' behavior. Instead, it is also possible that infants' behavior affected the parents' sensitivity in the interaction observations. However, we investigated correlations between the parents' behavior in the parent-infant interaction on the one hand and infants' behavior in the experimental tasks on the other hand. Thus, the interpretation of our results as effects of infants' behavior in the experiment on the parents' behavior in the interaction observation seems to be unlikely since it assumes a similar behavior of infants in the experiment and the observed parent-infant interaction, which, in turn, would had to have affected parents' sensitivity in the interaction observation. Moreover, previous studies reported longitudinal effects of parents' sensitivity on infants' social learning behavior (see Wolff & Ijzendoorn, 1997, for a meta-analysis). Therefore, although we cannot interpret our data in that way, it seems reasonable to assume that if our reported effects were investigated in a longitudinal design, significant evidence for effects of parents' sensitivity on infants' behavior in social learning situations could be obtained.

Methodological Advantages

There are certain advantages concerning the validity and generalizability of our results. First, many studies have shown the relevance of multi-contextual research as a necessary precondition for the generalization of the results (for a review see Gardner, 2000). As indicated by Study 4a and Study 4b, and in line with other findings (Borduin & Henggeler, 1981; Bornstein et al., 1997), no differences were found between the two observational appointments (about one week delay) and the two locations (laboratory and infants' homes) in terms of the interaction quality (see section 3.4.1 and 3.4.2 for detailed results). Thus, we are able to generalize the results across several observations and beyond the laboratory location. Second, we received evidence at a trend level that the observed quality of parent-infant interaction was related to the statements parents made in a parenting style questionnaire. This result cautiously indicates that the interaction quality we observed represented a trait rather than a state and, thus, slightly supports our assumption that infants indeed have experienced the observed alignment of parents' sensitivity in their everyday life and not merely in the laboratory context (see section 3.4.3 for detailed results). Third, in the reported effects of Study 4c, we controlled for infants'

temperament (measured based on parent questionnaire), meaning that this cannot account for our regression results in this study. Fourth, in Study 4c, we observed the parent-infant interaction either previous or subsequent to the hiding-finding task, without any differences in terms of infants' looking or object-search behavior in the experiment. This was done to rule out the explanation that the reported effects between parents' sensitivity and infants' increased visual attention to the informants were artificial and simply due to the activation of infants' attention by the parent in the previous interaction observation. The combination of these advantages contributes to the validity of our findings and, thus, increases the significance of the conclusions drawn based on our results.

Conclusion

In conclusion, an important finding of Study Set 4 was that infants of more sensitive parents received more information from both familiar and unfamiliar informants and were less selective in terms of an informants' familiarity when using information to solve a problem by social learning than infants of less sensitive parents. Thus, in none of our analyses the social learning behavior of infants of more sensitive parents was affected by the informants' familiarity – an aspect which was not relevant in order to learn about the valence of a novel object, to learn about how to perform a novel action, nor to get knowledge about the hidden object's location. Possibly those infants focused on more relevant aspects in the provided social learning situations (i.e. informants' knowledge states). Future research could investigate whether infants of more sensitive parents indeed focus more on those informants who are more relevant to the solving of a problem (e.g. knowledgeable informants) than to informants who are less relevant (e.g. ignorant informants), and whether this selectivity overwrites irrelevant informants' characteristics. Precisely because the current studies face some challenges and limitations, it is remarkable that the reported effects were consistent across different analyses within each paradigm. The methodological advantages of our studies emphasize the validity of these effects.

4. General Discussion

In this dissertation, we investigated whether infants' social learning behavior is selective in terms of the informants' knowledge states based on their local expertise and visual perspective. We further investigated whether infants' social learning behavior is selective in terms of the informants' familiarity and whether inter-individual differences of infants' learning from familiar and unfamiliar informants can be explained by interrelations with the quality of parent-infant interaction. To do so, we designed four study sets, each of them focusing on different aspects. In Study Set 1, we investigated whether infants at 14 months of age preferred to receive and use information from local experts, that is, the informants who were associated with the location in which the experiments took place (i.e. the experimenter in the laboratory and the parent in the infant's home). This local-expertise hypothesis derived from laboratory studies which discovered that infants preferred to receive and use information provided by an unfamiliar experimenter instead of the familiar parent (e.g. Stenberg, 2009). However, none of the existing studies sufficiently investigated this hypothesis by varying the location of the experiment. Therefore, we designed two studies: Each study presented infants with a familiar informant (i.e. the parent) and an unfamiliar informant (i.e. the experimenter), and each was conducted in both a familiar location (i.e. the infant's home) and an unfamiliar location (i.e. the laboratory). Infants' social learning behavior in both studies did not support the claims made by the local-expertise hypothesis, neither for infants' social referencing behavior in the exploration task (Study 1a), nor for infants' looking and imitative behavior in the imitation task (Study 1b). Thus, given the participants' performance in these tasks, *the current empirical evidence decidedly challenges the local-expertise hypothesis including familiar and unfamiliar informants*.

Study Set 2 consisted of two longitudinal studies, in which we focused on infants' selectivity due to others' knowledge states based on the informants' visual perspective. For this purpose, two informants directly differed in terms of their informational access and, thus, their knowledge about the location of an object in a hiding-finding game. In the within-subjects design of Study 2a, neither infants at 14 months of age nor at 19 months of age followed the referential cues of the knowledgeable informant more than those of the ignorant informant. Moreover, infants' looking behavior in both age groups did not provide any evidence that the infants expected the knowledgeable informant to indicate the correct location of the object. However, given a direct comparison of both age groups, the older participants tended to prefer the knowledgeable over the ignorant informants' cues more often than the same participants did about five months earlier, indicating the tendency of participants' increased use of others'

knowledge. We received complementary results in the modified hiding-finding game of Study 2b, in which we, among other things, used a constant pointing gesture instead of a physical marker as the referential cue – given the difficulty of infants to use a physical marker in Study 2a – and varied the informants' visual perspective between subjects. In this study, infants at 20 months of age but not at 14 months of age significantly preferred to use the referential cues provided by the knowledgeable informant more than those by the ignorant informant. Thus, *the results of both studies comprised evidence for a development of infants' selective use of others' knowledge in a hiding-finding game within their second year of life*. Moreover, whereas Study 2a emphasizes the expandable but developing ability of infants within their second year of life to use a physical marker as an abstract referential cue to indicate an object's location, Study 2b supports the results of previous studies about infants' ability to use a pointing gesture as a concrete referential cue to indicate a reference. Taken as a whole, Study Set 2 contributed new empirical evidence concerning the development of infants' use of referential cues as well as the development of infants' selective use of others' knowledge in their second year of life – two important abilities to share others' knowledge and to select and make use of reliable informants. A summarizing comparison of infants' selectivity due to the informants' knowledge states between Study Set 1 and Study Set 2 revealed that for infants at 14 months of age the information use was not affected by the informants' knowledge states, neither in terms of the informants' local expertise, nor in terms of the informants' visual perspective.

Regarding our question in what way an informant's familiarity had an impact on infants' selective social learning behavior, we received our first hint in the results of Study Set 1. In this study set, we discovered infants' preference to receive information from the unfamiliar rather than the familiar informant across both paradigms (i.e. social referencing and imitation task) and locations. In contrast, infants did not consistently use more information from a certain informant, that is, they did not use more emotional information in the social referencing task (Study 1a), and they did not consistently imitate the modeled action in the imitation task (Study 1b) from the unfamiliar informant more than the familiar informant. However, they explored the objects more when presented by the familiar than by the unfamiliar informant (Study 1a), and they spontaneously imitated the action more when it was modeled by the familiar than the unfamiliar informant (Study 1b). That is, Study Set 1 provided an interesting shift from a consistent preference in infants' information reception from unfamiliar informants to a lack of consistent preference for a certain informant when using information.

To further investigate the phenomenon of infants' selectivity to familiar and unfamiliar informants we designed Study 3. Certain improvements characterized this study compared to

Study Set 1, for instance, the longitudinal design, the use of same-gendered informants, the innovative application of a hiding-finding game as a paradigm to manipulate the informants' familiarity, the inclusion of a separate phase for infants' information search, the necessity for infants to make a decision between the familiar and the unfamiliar informant within each trial, and the requirement that infants indeed lacked information in the social learning situation. The results provide evidence for *infants' preference to look for information from the unfamiliar rather than the familiar informant at 14 and 20 months of age*. In contrast, *infants at both ages did not show such a preference for a certain informant when using information* in this hiding-finding game. However, a significant number of *infants at 14 months of age were nevertheless selective in terms of the informants' familiarity by either preferring to use information provided by the familiar or the unfamiliar informant*. In contrast, for infants at 20 months of age, the number of selective infants was equal to the number of non-selective infants, suggesting that *for the group of 20-month-olds the social learning behavior was not affected by the informants' familiarity* – an aspect which was not relevant to solve the problem in the present paradigm, that is, to find the hidden toy.

Finally, Study Set 4 focused on the interrelating effects between the quality of parent-infant interaction and 14-month-olds' social learning and its selectivity when deciding between familiar and unfamiliar informants. In particular, all three studies of this set included observations of the parents' sensitivity in terms of their active engagement based on the infants' focus of attention (Maintaining Attention), as well as in terms of their contingent, supportive, and warm reactions to the infants' signals and actions (Warm Sensitivity) in an object-based free play situation. In the social referencing task of Study 4a, we found consistent positive interrelations between parents' sensitivity and infants' information receptions from both the familiar and unfamiliar informant. *The more sensitively parents interacted with their infants, the more information infants received from both informants*. However, the interaction variables were not interrelated with infants' use of emotional information when exploring a novel box. In Study 4b and Study 4c, infants had to directly decide on their own within each trial which source of information to choose – the familiar or the unfamiliar informant. Thus, for both studies we examined the interrelation between parents' sensitivity and infants' preference for familiar versus unfamiliar informants. In the imitation paradigm of Study 4b, infants' information reception and imitative behavior was not interrelated with their parents' sensitivity. In contrast, based on the hiding-finding game in Study 4c, we found different patterns of selectivity. Whereas infants of more sensitive parents did not differentiate between a familiar and an unfamiliar informant when looking for information from the informants and using their

referential cues, infants of less sensitive parents did. Infants of less sensitive parents preferred to look for information from the unfamiliar rather than the familiar informant, and a significant number of those infants had either a selective preference to use the referential cues of the unfamiliar or the familiar informant. Thus, our results indicate that, depending on the social learning task, the parents' sensitivity in the parent-infant interaction was interrelated with the selectivity of infants' information reception and use in terms of the informants' familiarity.

To sum up, the current dissertation provides important findings for the existent literature of infants' selective social learning. We presented the first studies investigating the local-expertise hypothesis in different locations by using different paradigms – a social referencing paradigm from which the hypothesis arose, and a tool-use imitation paradigm. We presented furthermore the first studies investigating infants' use of others' knowledge when infants had to transfer others' information onto their own behavior while the infants themselves had no knowledge to solve a certain problem. Moreover, it was the first time a study provided evidence of the use of a physical marker as an abstract referential cue to locate a hidden object in infants in the second year of life. In addition, we presented the first study longitudinally investigating the impact of the informants' familiarity on infants' selective social learning in a paradigm in which infants directly had to decide whom to trust. Finally, we presented the first studies to investigate Maintaining Attention and Warm Sensitivity as important aspects of parents' sensitivity in relation to infants' selective social learning from familiar and unfamiliar informants by using different paradigms in different contexts. The implementation of these pioneer studies resulted in important empirical evidence and raised several new questions. In particular: Why did we not find evidence for 14-month-old infants' preference to use more information from a knowledgeable informant than from an ignorant informant although other studies claimed infants' ability to track others' knowledge and to take others' visual perspective into account? How could the phenomenon of infants' looking preference at the unfamiliar informant be explained if the local-expertise hypothesis is not a valid explanation for this phenomenon? Why did infants not use more information from the unfamiliar informant although they preferred to receive information from this informant? Moreover, why did infants of more sensitive parents not use more information from their parents than from an unfamiliar informant? How might these results be seen as pedagogically relevant? Finally, how can the variety of results of our studies be incorporated and interpreted with respect to the research on infants' selective social learning from reliable sources of information? These questions will be answered in the following General Discussion.

4.1 The Development of Infants' Use of Referential Cues

In order to investigate infants' selective social learning in the current dissertation, we applied different learning forms, which infants in the second year of life already make use of when learning from others. When presenting infants with a social referencing and imitation task, we knew that there is sufficient empirical evidence emphasizing infants' ability to use others' emotional expressions to evaluate a novel object (e.g. Feinman, 1982; Feinman et al., 1992; Hornik et al., 1987; Klinnert et al., 1986; Stenberg, 2009), or to imitate others in order to learn a modeled action (e.g. Buttelmann et al., 2008; Buttelmann et al., 2013; Gergely et al., 2002; Poulin-Dubois et al., 2011; Ryalls et al., 2000; Zmyj et al., 2012). Moreover, there was also sufficient evidence for infants' use of others' pointing gestures as object-directed referential cues (Aureli et al., 2009; Behne et al., 2005; Behne et al., 2012; Bretherton, 1991; Carpenter, Nagell et al., 1998; Desrochers et al., 1995; Leung & Rheingold, 1981; Murphy & Messer, 1977; Tomasello, 1999; Tomasello & Akhtar, 1995; Woodward & Guajardo, 2002). Therefore, infants begin to understand a person's pointing gesture as an object-directed action between the age of 9 and 12 months of age. Moreover, infants at 12 months of age even used others' pointing gesture when searching for a hidden object (Behne et al., 2012). To further facilitate infants' understanding and use of a referential cue, we combined a non-static pointing gesture with a physical marker as an abstract referential cue that was constantly indicating a reference location. However, there was a gap in research in terms of infants' use of such abstract referential cues, which makes our study a pioneer study. An advantage of those abstract referential cues is their potentially bidirectional production and comprehension (Tomasello, 1996). Thus, an abstract referential cue is potentially based on a shared understanding about its meaning. However, do infants within their second year of life also show such a shared understanding? There was only evidence for 2.5- and 3-year-old children. Participants at this age used a wooden block that was placed by an experimenter on one of three containers to indicate a hidden reward in a hiding-finding game (Tomasello et al., 1997). Children at 3 years of age also used light and sound cues as abstract referential cues to find a hidden reward (Moore et al., 2013). Thus far, no study had investigated the use of more abstract referential cues for infants in their second year of life. In two longitudinal studies we examined whether infants within their second year of life used an abstract (i.e. a physical marker in combination with a non-static pointing gesture) and a concrete (i.e. a static pointing gesture) referential cue to find a hidden object.

The results of Study 2a emphasize a development of infants' use of a physical marker to find a hidden object. Whereas our 14-month-old participants did not consistently use the physical marker in order to find a hidden object, 19-month-olds did. This development was indicated by

a significant improvement from 14 to 19 months of age. This finding represents, to the best of our knowledge, the first evidence for infants' use of physical markers as more abstract referential cues in their second year of life. These innovative findings are remarkable in terms of studies claiming children's problems with the understanding of symbols before the age of 3 (Callaghan, Rochat, MacGillivray, & MacLellan, 2004) and, thus, give reason to assume an earlier development of this ability. However, infants at 14 months of age had difficulties using physical markers, suggesting an increase of this ability within their second year of life. When using constant pointing gestures as more concrete referential cues, infants at 14 and 20 months of age followed the informants' cues to the location of a hidden object significantly above chance level and, thus, successfully inferred the communicative intent of the informants (Study 2b). This result supports previous findings about infants' use of pointing gestures as an object-directed communicative act already around their first year of life. Our results suggest that infants' use of constant pointing gestures seems to be relatively stable within the second year of life. Consequently, 14-month-olds' use of a constant pointing gesture on the one hand, and their lack of using a physical marker in combination with a non-static pointing gesture on the other hand, suggest that a concrete referential cue, such as a constant pointing gesture, is more appropriate to communicate referential information to infants at 14 months of age. This is in line with other findings, claiming that although 2.5- to 3-year-old children used a physical marker above chance level, those participants performed better when presented with a pointing gesture (Tomasello et al., 2007). This might refer to a challenge when using physical markers as referential cues, possibly because another cognitive step to infer the referent's intent is required, which is the concrete referential meaning of an abstract physical object.

To conclude, the present set of studies contribute important new evidence concerning the development of infants' use of concrete and abstract referential cues when searching for a hidden object. We ascertained a developmental pathway indicating that the use of more abstract referential cues significantly increases between infants' first and second halves of their second year of life. Moreover, infants' ability to use a pointing gesture as a more concrete referential cue was stable within the second year of life. Both the ability to use more abstract and concrete referential cues extends infants' possibilities to communicate with members of their cultural group. Especially for young infants, it is important for them to develop such prelinguistic communicative abilities in order to be able to share others' knowledge states and, thus, to learn from others about the world around them in multiple ways (Tomasello, 1999; Tomasello et al., 2007).

4.2 Infants' Selectivity due to Informants' Knowledge States

4.2.1 Infants' Selectivity due to Informants' Local Expertise

When infants learn about the world, they seem to be motivated to take others' knowledge states into account (Tomasello et al., 2005). This motivation is reasonable, because the more an informant knows about an entity, the higher is the relevance of the provided information. Thus, infants' ability to differ between knowledgeable and less knowledgeable informants and, consequently, to select the more knowledgeable informant, enables a better and more efficient process of problem-solving and learning. Referring to studies investigating infants' theory of mind, even young infants take different knowledge states of other agents in their social environment into account. In line with this, studies suggested that infants' selection of informants might be based on the informants' local expertise and thus their knowledge about the location with which they are associated (Stenberg, 2009; Stenberg & Hagekull, 2007). Results revealed that infants looked more at the unfamiliar than at the familiar person and that they played with the toy more when it had been presented by the unfamiliar rather than by the familiar person. However, these experiments only took place in the laboratory, meaning that the expert was always the experimenter but never the infants' parents. This left open whether the experimenter's local expertise truly drove infants' social learning. It was the author herself who pointed out the importance of varying the location of the study in addition to varying the familiarity of informants in order to draw acceptable conclusions about the validity of the *local-expertise hypothesis* (Stenberg, 2009). An initial investigation of this hypothesis was a study that claimed to test 6-month-olds' imitative behavior by varying both informants' familiarity and the location of the experiment. In the laboratory location, 5 out of 14 infants copied the action modeled by the experimenter, whereas only 3 out of 14 infants copied the action modeled by the infant's parent. In the home location, these numbers were reversed, leading the authors to conclude that infants' imitative behavior was sensitive to both types of cues. However, the modeled action demonstration could have been merely emulation and, moreover, the authors did not compare both conditions directly. Thus, further evidence was needed, beyond the laboratory location, to ascertain whether the local-expertise hypothesis is a valid explanation for infants' preference for the experimenter over the parent in prior studies. Our current results from Study Set 1 provide evidence against this theoretical view: Infants were neither selective in their reception nor in their use of information provided by the local expert (i.e. the experimenter in the laboratory and the parent in the infant's home). Instead, in both locations infants received more information from the experimenter, explored the objects more when the parent presented them, and spontaneously imitated the parent rather than the experimenter.

Thus, our results are in line with other findings claiming 14-month-olds receive more information from the unfamiliar informant (Stenberg, 2003, 2009; Stenberg & Hagekull, 2007; Walden & Kim, 2005; Zarbatany & Lamb, 1985), but to be more affected by the familiar informant when acting on the presented objects (Zarbatany & Lamb, 1985).

With our studies, we investigated infants' selective social referencing and imitative behavior in two different locations and – for each infant – two contrasting informants associated with a certain location, for the first time in this research field. The findings raise questions for alternative interpretations of others' and our results in terms of infants' looking preference for the unfamiliar informant in the unfamiliar location (for a comprehensive discussion of an interpretation focusing on the experimenter's novelty, see section 4.3.1; for a discussion about further alternative interpretations, see section 3.3). Instead of a local-expertise hypothesis, participants' looking preference as receiving information from unfamiliar informants might be explained by an object-expertise or action-expertise hypothesis. Such an object-expertise or action-expertise hypothesis assumes that infants receive more information from those informants who are associated with the objects or actions about which they provide information. Thereby, infants might have associated the novel objects or actions with the novel experimenter and thus could have ascribed more expertise about those objects or actions to the experimenter than to their parent. This could have happened in combination with an ascription of possession or ownership meaning that infants assumed the experimenter to own the explorative and imitative objects and thus to have knowledge about them. This would be in line with claims about the emerging sense of alienable ownership by infants approximately 9 months of age onwards (Rochat, 2014). To test such an object- or action-expertise hypothesis is a challenge for future studies. It remains to be explained why infants in our studies regulated information reception but not their information use in accordance with the experimenter's object-expertise or action-expertise.

However, assuming that infants do ascribe such an object-expertise and action-expertise to informants, it is possible that the local-expertise hypothesis is only valid if one include objects and actions that differ in accordance with the location in which the learning situation takes place (i.e. novel objects/actions in the novel location; familiar objects/actions in the familiar location). Indeed, one could argue that the association between the parent and the infant's home was not as strong as the association between the experimenter and the laboratory location due to the presence of novel objects and actions in both locations. Infants could have associated these novel objects and actions with the experimenter in both the laboratory and the infants' homes. Thus, adapting the novelty or familiarity of demonstrated actions in accordance to the learning

context might result in a more appropriate investigation of the local-expertise hypothesis for infants' imitative behavior. However, in our and other social referencing studies, the inclusion of novel ambiguous objects was an important prerequisite for eliciting infants' social referencing. If we or other researchers would have used familiar objects in the home location, there would not have been any need for infants to gather information about these objects. Thus, in order to investigate the local-expertise hypothesis as an explanation for infants' social referencing behavior, it was important to use novel ambiguous objects in both locations.

Furthermore, although the local-expertise hypothesis obviously is not a valid explanation for infants' behavior in our and previous studies involving familiar and unfamiliar informants, the hypothesis itself does not necessarily have to be invalid. The lack of evidence supporting this hypothesis might be due to the informants' familiarity reflecting an influencing or disruptive factor, which might have overwritten the impact of informants' local expertise on infants' social learning. Thus, the local-expertise hypothesis should be investigated not along with a manipulation of the informants' familiarity but with a manipulating of local expertise by having similar novel informants.

Infants' non-selectivity in terms of the informants' knowledge states based on the informants' local expertise raised questions about infants' general ability to select knowledgeable informants. Based on the local-expertise hypothesis, infants had to infer that the local expert possessed relevant information about the object or action due to her/his context association. It is possible that this included too many inferential steps, beginning with the ascription of a local expertise based on the association with the location in a first inferential step (i.e. the informant who is associated with the location is knowledgeable in this location), and progressing with the ascription of knowledge about the objects presented and actions modeled based on the informant's local expertise in a second inferential step (i.e. the informant who is knowledgeable in this location is knowledgeable about the objects/actions). Assuming the challenges of these inferential steps exceeded infants' cognitive capacities, it seems to be necessary to manipulate an informant's knowledge state more directly by reducing the number of inferences. To address this issue we designed and conducted Study Set 2, in which the informants' knowledge states were more directly manipulated by varying the informants' informational access based on their visual perspective.

4.2.2 Infants' Selectivity due to Informants' Visual Perspective

Study Set 2 presented infants with informants who differed in terms of their knowledge states based on the informants' visual perspective in a hiding-finding game. In this study set, one informant observed the hiding of an object and thus had knowledge about its current location, whereas the other informant did not observe the hiding and thus had no knowledge about the object's location. The informants' visual perspective therefore was a relevant basis in order to know the location of the hidden object. There was evidence for a tendency of a development of this ability within the second year of life in Study 2a. Moreover, in Study 2b, infants at 20 months of age, but not at 14 months of age, significantly preferred to use the referential cues provided by the knowledgeable rather than the ignorant informant. Thus, both studies underline the developmental pathway of infants' selective use of others' knowledge in a hiding-finding game within the second year of life. These results shed new light on the discussion of infants' ability to understand others' perspective. For instance, as suggested by Piaget and Selman's stage theory of role taking, before the age of 6, children seem to be unaware of any perspectives other than their own (Piaget, 1962; Selman, 1984). In contrast to this claim and more in line with our results, more recent studies indicate that even 12- to 18-month-old infants are able to take others' perspective into account. However, although these studies provide evidence of infants' ability to take others' visual perspective into account at Level 1 of perspective taking (i.e. 'what we see is different'), those studies based their inferences only on infants' looking behavior (Brooks & Meltzoff, 2002; Luo & Baillargeon, 2007; Poulin-Dubois et al., 2013; Sodian et al., 2007) or infants' selectivity when providing objects or referential information for others (Liszkowski et al., 2008; Moll et al., 2007; Moll & Tomasello, 2007). Thus, none of the studies investigated the behavioral consequences of others' visual perspective on infants' use of others' information.

However, given that only the older infants in Study 2b made use of the informants' knowledge states, our hypothesis of infants' selective use of the knowledgeable informants' information can only be supported by the results of infants at 20 months of age. One might wonder why in certain studies even 1-year-olds were able to take others' visual perspective into account, whereas in our studies we did not find such evidence for infants at 14 months of age. One crucial reason might be that infants in our study had no knowledge about the objects' location, whereas infants in other studies knew were the object was. For example, in a study, infants at 12 months of age observed an object falling down while an experimenter either did see (knowledgeable experimenter) or did not see (ignorant experimenter) the object's fall (Liszkowski et al., 2008). Infants pointed more often to the object's current location for the

ignorant experimenter than to the knowledgeable experimenter, indicating their sensitivity to the informants' knowledge states. This study measured whether infants provided information selectively based on the informants' visual perspective, when the infants themselves were knowledgeable. In contrast, in our studies we measured whether infants used information selectively based on the informants' visual perspective while themselves being ignorant. Infants' ignorance about the objects' current location in our studies was due to infants' blocked visual perspective during the action of hiding, resulting in infants' lack of information and, with it, their need to use others' information. This lack of information likely resulted in another challenge or required another cognitive step when evaluating and taking others' knowledge states into account and, thus, possibly explains why other studies that also measured infants' active behavior response did find evidence for this ability at an earlier age than we did. Interestingly, in none of the reported studies investigating infants' ability to take others' visual perspective into account (Brooks & Meltzoff, 2002; Liszkowski et al., 2008; Luo & Baillargeon, 2007; Moll et al., 2007; Moll & Tomasello, 2006; Poulin-Dubois et al., 2013; Sodian et al., 2007), and none of the reported studies investigating infants' theory of mind (Buttelmann et al., 2009; Buttelmann et al., 2015; Clements & Perner, 1994; Doherty, 2009; Kovács et al., 2010; Onishi & Baillargeon, 2005; Southgate et al., 2007; Wellman et al., 2001; Wimmer & Perner, 1983), did infants themselves lack of knowledge about the entity. Therefore, our studies provide a special approach to investigate infants' ability to transfer their own knowledge about others' visual perspective and, thereby their own knowledge about others' knowledge, onto their own selective use of information provided by more or less knowledgeable informants.

It is further possible that the difference between infants' states of knowledge or ignorance explains why studies investigating infants' theory of mind presented evidence supporting this ability already in infants at 7 (Kovács et al., 2010) or 15 months (Onishi & Baillargeon, 2005) of age. Moreover, the difference between the findings of these and our studies could also be due to the different types of measurements, that is, infants' looking behavior in the theory of mind studies versus infants' active response behavior in our studies. This explanation is also supported by studies that similarly measured infants' active response behavior rather than their mere looking behavior in that evidence of infants' ability of theory of mind was not found before the age of 18 months (Buttelmann et al., 2009).

Moreover, although we found a tendency of an increase in infants' use of the informants' knowledge to search for a hidden toy from 14 to 19 months of age, the 19-month-old participants still did not significantly prefer to use the knowledgeable informant's information

over that of the ignorant informant in Study 2a. However, participants at 20 months of age significantly preferred to use information from the knowledgeable than the ignorant informant in Study 2b. One might wonder why 20-month-olds in Study 2b were selective in terms of the informants' knowledge states, whereas the 19-month-olds in Study 2a were not. One reason might be the mean difference in participants' age. Possibly, the emergence of infants' ability to use others' information in a hiding-finding game was found to be at 20, but not at 19, months of age. This would correspond to the findings in Study 2a, which reflect a developmental pathway of this ability within infants' second year of life. However, another reason might concern the differences between the two studies regarding their task requirements. Since infants within their second year of life seem to have difficulty using a physical marker as an abstract referential cue, we modified the paradigm of Study 2a. In Study 2b, we used a constant pointing gesture instead of a physical marker because even infants at the beginning of their second year of life repeatedly showed their ability to use others' pointing gestures as referential cues (see the previous chapter 4.1). Moreover, we presented infants with only one informant, instead of two, and manipulated her/his knowledge state between subjects in order to reduce the cognitive demands of the task when tracking the informants' visual perspective. By reducing the amount of different informants per infant, we also eliminated possible confusion caused by two conflicting indications at the same time. Finally, we used smaller toys that the experimenter could hide within her/his hands, invisible to infants, instead of using an occluder to cover the hiding action which might have also distracted infants' attention in Study 2a (see Behne et al., 2005, for a similar explanation). These modifications might have enabled 20-month-olds to selectively take the informants' knowledge states into account in Study 2b. That our 20-month-olds were able to selectively take the informants' knowledge states into account is even more remarkable since, during the hiding sequence, the informants in our study did not show joint engagement between the entity (i.e. the objects hidden in the boxes) and the infants, unlike studies in which infants knew what others experienced only based on informants' joint engagement (Moll et al., 2007). In our studies, it was only the informants' visual perspective that led to the positive effects, although it is possible that with informants' joint engagement we would have found clearer effects.

That the task design in general might affect children's and infants' use of other people's knowledge is possibly supported by the different results in theory of mind studies. In those studies, depending on the task, 7- to 15-month-olds showed surprise at an action when this action was inconsistent with the agents' beliefs, 2-year-olds anticipated actions based on the agents' false belief, and children around four years of age succeeded in explicit false belief

tasks (Buttelmann et al., 2009; Buttelmann et al., 2015; Clements & Perner, 1994; Doherty, 2009; Kovács et al., 2010; Onishi & Baillargeon, 2005; Southgate et al., 2007; Wellman et al., 2001; Wimmer & Perner, 1983). The significant differences of positive results in theory of mind studies might be, to some extent, due to the kind of task that was used and the abilities the task required in order to successfully fulfill it. However, whether the task requirements were indeed responsible for the different findings in theory of mind studies, as well as the different findings in Study Set 2, cannot be conclusively answered in this discussion and rather reflects a task for future research.

4.2.3 Conclusion

To conclude, our data do not support the local-expertise hypothesis including familiar and unfamiliar informants for infants at the beginning of their second year of life. However, assuming that infants do not selectively use others' knowledge before the age of 20 months, it is possible that the 14-month-old participants in Study Set 1 were not able to make use of an informant's local expertise and therefore knowledge state regarding the objects or actions in the corresponding location. Therefore, it might be worth investigating the local-expertise hypothesis by having older participants, for example, infants in the second half of their second year of life. Moreover, to affect infants' information reception and use, it seems to be necessary that the informants' knowledge states differ more directly in terms of informational access. It is possible that this more direct informational access was a crucial factor in Study Set 2, enabling us to discover a developmental pathway in infants' selectivity due to informants' knowledge states based on their visual perspective in the second year of life. In these pioneer studies we used a special approach to investigate the behavioral consequences of others' visual perspective on infants' use of others' information. To increase infants' need to use others' information, it was important to present infants with a lack of information. This lack of information, meaning that infants themselves were not knowledgeable, reflects a crucial difference between this and previous studies investigating infants' ability to take others' visual perspective into account, as well as to previous studies investigating infants' theory of mind. This special feature highlights the significance of our results, indicating that the need of others' information in a concrete situation, the directness of informants' informational access, the infants' age, as well as the experimental task requirements, might play an important role when investigating infants' ability to selectively use others' knowledge. Such an environment allowed infants in their second year of life to express their "special motivation to share psychological states with other persons" (Tomasello et al., 2005, p. 7).

4.3 Infants' Selectivity due to Informants' Familiarity

4.3.1 Understanding Infants' Looking Preference for the Unfamiliar Informant

An Apparently Surprising Result

Based on the importance of parents for infants' learning and development, we hypothesized that infants selectively receive information by looking at the familiar rather than the unfamiliar informant as a more reliable source of information. In Study Set 1 and Study 3, however, infants showed a preference in their information receptions from the unfamiliar rather than the familiar informant. These results are surprising for many reasons, first of all, with respect to the huge amount of empirical evidence highlighting infants' looking preference for familiar stimuli and faces in non-ambiguous situations without social interactions (Brooks-Gunn & Lewis, 1981; Roder et al., 2000; Rose et al., 1982), and for familiar over unfamiliar faces in social interactions (Ainsworth, 1964; Bartrip et al., 2001; Bushneil et al., 1989; Bushnell, 1998; Field et al., 1984; Kahana-Kalman & Walker-Andrews, 2001; Montague & Walker-Andrews, 2002; Pascalis et al., 1995). Second, the results are surprising with respect to attachment theory, because infants between 6 to 8 months and 18 months of age are usually in the clear-cut-attachment phase. In this phase, infants actively seek contact with their parents, and for most infants, the mother now functions as a secure base, facilitating infants' exploration and control of their environment. Third, the results are surprising in terms of "the fear of strangers", which was postulated by attachment theory (Bowlby, 1969, p. 323), and which might elicit more negative affect when infants observe unfamiliar as opposed to familiar adults (Kahana-Kalman & Walker-Andrews, 2001). Given the developmental increase of such a stranger aversion at 9 or 10 months of age (Ainsworth, 1967), and its peak in intensity in the second half of the first year of life (Tennes & Lampl, 1964) or within the second year of life (Morgan & Ricciuti, 1969), the looking preference of our 14- and 20-month-old participants to unfamiliar informants is once again remarkable. Or is it rather logical and in line with the claims of attachment theory? The parent was present during the entirety of the experiments in each of the studies of the current dissertation and, thus, could function as a secure base facilitating infants' exploration of the environment. The presence of the parent as a secure base could explain infants' confidence in exploring the experimenter by looking at her/him or infants' confidence in exploring the environment by using the experimenter as a source of information. It is questionable whether infants would continue to show such an increased motivation to look at the unfamiliar informant if the parent would not be present. Moreover, the looking preference at the unfamiliar informant does not necessarily exclude the fear of strangers. It is possible that infants' looking was

motivated by a feeling of fear or at least uncertainty, skepticism, and/or caution concerning the novel and unknown experimenter. Possibly, based on the presence of their parents as secure base, infants tried to engage with the experimenter in order to get to know her/him and, thus, to decrease their own feeling of uncertainty in terms of the novelty of the experimenter. Moreover, the gender differences between the unfamiliar and familiar informant in Study Set 1 might have influenced infants' increased amount of visual attention to the unfamiliar male informant compared to the parent, who was a female informant in most of the cases. However, as reported in the control analyses of Study Set 1, there were no differences in infants' looking time between same-gendered and different-gendered informants. Additionally, in contrast to Study Set 1, we had same-gendered informants in Study 3 and the looking preference for the unfamiliar informant was still persistent, indicating that infants' looking preference in Study Set 1 and Study 3 was not influenced by the differing genders of the informants.

Receiving Information about versus from a Novel Informant

Thus far, we cannot rule out that infants' looking preference might be explained by the *novelty of the experimenter*. This would mean that infants' looking behavior was not related to the information provided by the unfamiliar informant and that they therefore possibly did not receive information from the experimenter but rather about the experimenter given that s/he was a novel informant. Based on the process of habituation-dishabituation (see Introduction, section 1.3.2), one could argue that a familiar stimulus (e.g., a familiar informant) elicits less attention than a novel stimulus (e.g., an unfamiliar informant) (see Thompson & Spencer, 1966, for the original study introducing the habituation-dishabituation paradigm). Therefore, infants' looking preference at the experimenter over the parent possibly reflects such an increase of attention to a new stimulus (i.e. dishabituation) – the experimenter – compared to the decrease of attention to repeated and thus familiar stimuli (i.e. habituation) – infants' parents. Studies that made use of the habituation-dishabituation paradigm indeed have shown that infants' visual attention to novel stimuli was increased in comparison to familiar stimuli (Fantz, 1964; Rose & Tamis-LeMonda, 1999). Another supporting argument for the novelty interpretation is that infants' looking preference was also present in the neutral trial of Study 1a, in which none of the informants provided any information (see section 3.1.1). However, it is possible that infants in this trial preferably expected the unfamiliar informant to provide information for them. Moreover, an argument against the novelty explanation concerns infants' joint engagement, which was measured via the number of infants' gaze shifts between the informants and the object or action. This looking behavior likely related the provided information with the object or action and, thus, exceeds the mere looking at an informant. One might wonder whether

infants cognitively combined the novel objects or actions with the novel informant because they attributed more knowledge about the object and action to this informant. This is possible. However, it is also possible that infants just showed joint engagement more with the unfamiliar informant than the familiar informant because both the unfamiliar informant and the object were novel. The increased novelty might have elicited infants' increase in gaze switches. If so, it has to be explained why other studies found a preference for infants (9 to 24 months of age) to look more at pictures of their parents than at those of strangers (Brooks-Gunn & Lewis, 1981). Additionally, one has to explain the results of a study that manipulated an informant's novelty in a social referencing task by either playing with infants prior to the experiment for approximately 15 minutes (less-novel experimenter) or do not playing with infants prior to the experiment at all (novel experimenter). In this study, infants looked more at the less-novel experimenter than at the novel experimenter (Stenberg, 2012). Therefore, the simple novelty explanation cannot sufficiently explain our results and, more importantly, it does not take the circumstances under which the results occurred into account. Upon closer inspection of the experimental framework, one notices that infants' behavior was embedded in ambiguous situations in which infants' need for information played an important role. Therefore, our results are in line with and should be discussed in the light of studies that investigated infants' looking behavior under similar conditions (Stenberg, 2003, 2009; Stenberg & Hagekull, 2007; Walden & Kim, 2005). With respect to this evidence and the preceding discussion, we can conclude that infants likely do not have a looking preference for the unfamiliar person per se, but that this pattern can be consistently observed in situations which are characterized by ambiguity and therefore an increased relevance of information provided by certain informants. This consideration of the circumstances substantiated the assumption – that has to be investigated in future studies – that infants' looking preference indeed was related to the *motivation to receive information from rather than about the unfamiliar informant*. Note, however, that when discussing infants' motivation of looking at others, one also should be aware of inter-individual differences. Thus, it is possible that the looking behavior of each infant reflects a certain expression on a continuum between, for instance, the motivation to decrease the fear of the novel stranger by looking at her/him, on the one hand, and the motivation to solve a problem by looking at a novel informant in order to receive information about an entity, on the other hand. Based on the discussion of the motivations behind the looking behavior for the group of infants, we assume that most infants who preferred to look at the stranger were mainly motivated by gathering information from the novel informant about an entity – an ability that is still developing within infants' second year of life (Baldwin & Moses, 1996).

Receiving Information from the Confident Object/Action-Expert?

According to the interpretation of infants' visual attention as preferring to receive information from the unfamiliar rather than the familiar informant, it is necessary to raise the question of infants' underlying motivation for this preference once again. As we have argued in the discussion above, infants' preference cannot be explained by the local-expertise hypothesis. However, it is possible that infants' preference can instead be explained by an object-expertise or action-expertise hypothesis (see section 4.2.1). This might be supported by infants' perception of the informants' certainty and confidence when providing information in the experimental setting. Assuming that infants' looking preference is not due to the mere association of the novelty of both the unfamiliar informant and the novel objects and the novel actions, it might be due to infants' perception of the experimenter as the person who is more certain and confident about the experimental procedure than their parents are. This interpretation corresponds to studies showing evidence for infants' and children's preference for informants who appear certain and confident (Birch et al., 2010; Matsui et al., 2006; Moore et al., 1989; Poulin-Dubois et al., 2011; Sabbagh & Baldwin, 2001). The experimenter, compared to infants' parents, might have expressed an increased certainty and confidence not only in the laboratory location but also generally based on the fact that it was the experimenter who initiated the experimental procedure. Thus, the experimenter clearly knew what to do and to say, whereas parents had to receive instruction about and learn the procedure within a comparably short time frame. This could have resulted in differences in terms of the certainty and confidence of the informants' actions. However, we trained the parents prior to the experiment and told them, for example, to provide their emotional expressions about the novel object as they do in their everyday interactions with their infants. Moreover, we checked for and excluded those trials in which parents did not behave in the prescribed manner of acting. Thus, we made sure that both infants' parents and the experimenter were acting as comparably as possible throughout the experiment. This does not eliminate but does reduce the likelihood that infants' looking preference for the experimenter is based on infants' evaluation of the experimenter as a more certain and confident and, thus, more reliable source of information in this experimental context. If so, one could expect infants to also use more information from the unfamiliar rather than the familiar informant. However, this was not the case, as we will discuss in the following sections.

4.3.2 Infants' Lack of Preference when Using Information from Familiar and Unfamiliar Informants

A "familiarity effect" in infants' social learning could be well explained by the infants' early experiences in their mothers' wombs (Walden & Kim, 2005, p. 360; Fifer & Moon, 1995; Gandelman, 1992; Robertson, 1990). Moreover, in accordance with attachment theory, the parent is a secure base from which infants become competent and learn about the world. For this, especially in the clear-cut-attachment phase, infants fall back upon their parents by actively searching for and using their interactive contact (Bowlby, 1969; Waters & Cummings, 2000). Additionally, empirical evidence supports 14-month-olds' preference for familiar over unfamiliar informants in a social referencing paradigm (Zarbatany & Lamb, 1985). Given this relevance of parents for infants' learning and development, we hypothesized that infants would selectively use information provided by the familiar over the unfamiliar informant and thus choose the familiar informant as a more reliable source of information (Study 3).

In line with this, our observations of infants' selectivity when using others' information seem to emphasize a preference for familiar informants at a first glance (see Study Set 1). In Study 1a, infants explored the novel boxes more when they were presented by the familiar than by the unfamiliar informant. Moreover, the same preference occurred in terms of infants' spontaneous imitative behavior (Study 1b): In the first trial, more infants used the parent tool than the experimenter tool in order to imitate a modeled action on an object. Assuming the infants' parents to be an in-group member for infants, these results of Study Set 1 are in line with studies claiming a preference for in-group over out-group members. For example, infants at 6 months of age preferred to look at an adult who had previously spoken their native language than at an adult who had previously spoken a foreign language (Kinzler, Dupoux, & Spelke, 2007). The authors also showed that participants at 10 months of age preferred to take an object from a native-language speaker even though a foreign-language speaker offered the identical object to the infants. Moreover, infants at 14 months of age imitated actions demonstrated by an in-group member significantly more often than actions demonstrated by an out-group member (Buttelmann et al., 2013). In this study, participants watched an adult telling a story either in their native language (in-group) or a foreign language (out-group). The model then demonstrated a novel action (imitation task) and chose one out of two objects (preference task). Infants were not selective in the preference task when they themselves could choose one of the two objects, although they imitated the in-group model more faithfully than the out-group model. We want to point out that one has to be careful with a direct comparison between infants' preference for familiar informants and in-group members, since infants' preference for in-group

members in these studies might be due to the language comprehension and similarity, irrespective of a familiarity in terms of shared experiences over a longer period of time.

Moreover, a further look at our results clarifies that the power of a possible familiarity effect was not strong enough to influence infants' use of emotional information when exploring a novel box (Study 1a), influence infants' imitative behavior across the trials (Study 1b), nor affect infants' use of parents' referential cues in their object-search behavior (Study 3). For Study 1a, although infants were more explorative when the familiar rather than the unfamiliar informant presented the box, the exploratory behavior was not affected by the different kinds of emotions. Thus, strictly speaking, infants did not use the emotional information in Study 1a, neither from the familiar nor the unfamiliar informant. Moreover, for Study 1b, infants' imitative behavior did not differ between familiar and unfamiliar informants across the trials. This is in line with other findings indicating young infants' comparable facial imitation of familiar and unfamiliar adults. In this study, 6-week to 3-month-old infants imitated both the facial expressions of a stranger and their mother (Meltzoff & Moore, 1992). Moreover, for Study 3, we also did not find a difference between familiar and unfamiliar informants in infants' use of pointing gestures when searching for a hidden object. Overall, there is evidence that infants did not show a consistent familiarity preference – and no consistent preference for the unfamiliar informant – when using the informants' information. This, in turn, refers to a gap between infants' reception and use of information provided by familiar and unfamiliar informants.

4.3.3 The Gap between Infants' Reception and Use of Information

Based on the previous discussion about the interpretation of infants' looking preference at the unfamiliar informant, we concluded that in our studies this preference can be interpreted as receiving information from this informant. This interpretation raises the question: Why did infants not use the information from the informant from whom they preferred to receive information about an entity? One reason might be that the reception and use of information are two different mechanisms in infants' social learning processes. Thus, to assume an interrelation between receiving information from an informant and using her/his information demonstrates an expectation for a genuine relationship that might not exist. It is instead possible that, subsequent to receiving information from informants, the use of others' information constitutes a further step in the information transfer. The mere *reception* of information does not have any direct consequences for infants when learning, for example, about the valence of an object or the manner of how to perform a novel action. The *use* of others' information, in contrast, reflects

a more direct impact on infants' learning behavior. In this respect, the use of information might be more relevant for infants who are likely to need good reasons and a minimum level of trust or confidence to use provided information from informants. Given the informant's unfamiliarity, infants may lack the trust or confidence to use information from a person whom they do not know and of whose reliability infants have almost no experiences. Accordingly, the informants' unfamiliarity could have raised doubts about the relevance of her/his information. If so, it is necessary to explore why infants preferred to receive information from the unfamiliar informant when this informant was possibly expected to provide irrelevant information. However, one can imagine that infants did not have any specific expectations before they received information from the informants, but that infants evaluated the informants' reliability in the moment they paid visual attention to the informants. The result of this evaluation, in turn, might have influenced whether or not infants used the informants' information. This process would be able to explain the gap between infants' visual attention to informants (i.e. *evaluating the informants' reliability*) and the use of their information (i.e. *using information from reliable informants*). That infants preferably use information from reliable informants has been pointed out in previous studies (Chow et al., 2008; Koenig & Echols, 2003; Koenig & Sabbagh, 2013; Poulin-Dubois et al., 2011; Ryalls et al., 2000; Zmyj et al., 2010; Zmyj et al., 2012; see Harris & Lane, 2013; Lucas & Lewis, 2010 for reviews). In these studies, the informants' reliability was manipulated by presenting infants with different reliable informants to whom infants paid visual attention. Based on these experiences infants gathered expectations about the informants' reliability, leading to a selective effect on infants' learning behavior. Thus, infants' reception and use of information might not necessarily be related to each other. Rather, infants' visual attention to others might serve as a basis for infants' evaluation of others' reliability. Thus, infants possibly use the informants' information only in those cases in which the evaluation resulted in an ascription of reliability. For further discussion, see section 4.6.

4.3.4 Infants' Selectivity due to Informants' Familiarity Depends on Infants' Age

As discussed in section 4.3.2, infants at both ages did not show a preference for a certain informant when using information from familiar and unfamiliar informants. However, in Study 3, a significant number of infants at 14 months of age were nevertheless selective in terms of the informants' familiarity. Those infants either preferred to follow the referential cues of the familiar or the unfamiliar informant in order to search for the hidden object. Interestingly, this evidence of an inconsistent selectivity reflects the inconsistent findings of other studies using a social referencing paradigm, in which infants either preferred to use information from

unfamiliar informants (Stenberg, 2009; Stenberg & Hagekull, 2007) or familiar informants (Zarbatany & Lamb, 1985).

In contrast to the selectivity of infants at 14 months of age, the number of selective infants was equal to the number of non-selective infants for infants at 20 months of age. This indicates that the social learning behavior was not affected by the informants' familiarity for infants at 20 months of age. Remarkably, the informants' familiarity was an aspect irrelevant to the finding of the hidden toy in the present paradigm, since both informants observed the hiding and were therefore knowledgeable about the object's location. This result leads to a new assumption that has to be investigated in future studies: Infants at 14 months of age are more vulnerable to irrelevant aspects than infants at 20 months of age, who might be better able to focus on more relevant aspects when solving problems in social learning situations. This assumption is supported by the results reported in Study Set 2, which emphasized a trend of development of taking an informant's knowledge state into account within infants' second year of life (Study 2a). This development is further indicated by the finding that infants at 20 months of age but not infants at 14 months of age successfully used the informants' knowledge states to search for a hidden object (Study 2b). Thus, for infants at 20 months of age, the relevant aspect of informants' visual perspective and thus knowledge states affected infants' information use, whereas the irrelevant aspect of the informants' familiarity did not affect infants' information use. In contrast, for infants at 14 months of age, this pattern was reversed, suggesting that infants' ability to focus on more relevant aspects when evaluating the informants' reliability increases within the second year of life. However, to what extent an informant's knowledge as a more relevant aspect in this paradigm would indeed overwrite the effect of an informant's familiarity should be investigated in future studies by manipulating both aspects in one experiment.

4.3.5 Conclusion

Infants within their second year of life preferably pay visual attention to an unfamiliar rather than a familiar informant when they are provided with information in a novel or ambiguous situation. For this looking pattern, the mere novelty interpretation does not sufficiently explain infants' preference. Rather, supporting evidence encourages an interpretation of infants' looking preference for the unfamiliar informant as looking for information. It should be further investigated whether this can be explained by an *object-expertise or action-expertise hypothesis*, and whether this is related to infants' perception of the experimenter as more certain and confident in terms of the experimental procedure. However, there was no such preference

for the unfamiliar informant concerning infants' information use, possibly indicating that the process of evaluating others as reliable informants was still in progress. Thus, the gap in preference between infants' information reception from unfamiliar informants on the one hand, and their lack of preference for a certain informant when using information on the other hand, might be explained by infants' ongoing evaluation of the informants' reliability while paying visual attention to them. Therefore, infants probably would have shown a preference for one or the other informant only when they had ultimately evaluated one informant as more reliable than the other. However, in all of our studies, the informants provided information which did not differ in its relevance – they provided the same emotional information about the valence of novel objects (Study 1a), their tool use resulted in the same effects when demonstrating a novel action (Study 1b), and their referential cues to the location of a hidden object did not differ in their valid prediction, since infants did not get feedback about the object's location (Study 3). Thus, the only core difference between the two informants remains to be their familiarity to the infants, a factor which was not relevant to learning about the valence of a novel object, the manner of performing a novel action, or the location of a hidden object. Interestingly, whereas the social learning behavior of infants at 20 months of age was not affected by the informants' familiarity, the social learning behavior of infants at 14 months of age was. This raises the assumption that infants at 14 months of age are possibly more vulnerable to irrelevant aspects than infants at 20 months of age, who might be better able to focus on more relevant aspects when solving problems in social learning situations. This hypothesis has to be investigated in future research.

4.4 The Importance of Parents' Sensitivity for Infants' Social Learning

In most cultures, infants spend their first year of life at home with numerous interactions with their parents who potentially provide a secure base for learning and development (Bowlby, 1969). Within these interactions, infants persistently signal their current state of well-being (e.g., smiling, babbling, exploring, sleeping, crying due to hunger, thirst, tiredness, illness, or fear). Previous research demonstrated that the parental responses to these and other types of infants' signals and behaviors influence infants' learning and development (see section 1.4.1). A crucial characteristic of parental responses to infants' signals and behaviors is the parents' sensitivity, the ability to accurately interpret and to respond promptly and appropriately to infants' signals (Ainsworth et al., 1974). As highlighted in the introduction, the parents' sensitivity is often measured in terms of infants' basic needs (i.e. physical and emotional needs). However, given the satisfaction of these needs and the dynamic development of cognitive and

motor abilities especially in infants who exceeded the first year of life, the active acquisition of knowledge and the exploration of the environment based on infants' intentions and focus of attention becomes more and more relevant. Therefore, it is important to measure parents' sensitivity to infants as intentional beings with their own focus of attention. In the current dissertation, similar to previous studies (Bartling et al., 2010; Landry et al., 1998), we investigated the alignment of parents' sensitivity in terms of their contingent, supportive, and warm reactions to the infants' signals and actions (Warm Sensitivity) as well as their active engagement based on the infants' focus of attention (Maintaining Attention) in an object-based free-play situation. This was done to investigate interrelations between the quality of parent-infant interaction and infants' social learning from familiar and unfamiliar informants.

4.4.1 Interrelations between Parents' Sensitivity and Infants' Social Referencing

There is evidence that these variables of parents' sensitivity are related to infants' visual attention to the parent (Legerstee et al., 2007) and the reception of her/his emotional information (Montague & Walker-Andrews, 2002), as well as to infants' reception of information from unfamiliar informants and the use of their emotional information (Varghese, 2007). However, as mentioned in the introduction, further evidence was missing in terms of the validity of these social referencing effects for infants in the second year of life. Based on our social referencing task, we reported supportive evidence for the previous findings in terms of infants' information reception: The more sensitively parents interacted with their infants, the more information infants received from both the familiar and unfamiliar informant (Study 4a). This result confirms further findings claiming positive interrelations between parents' sensitivity and infants' visual attention to their mothers (Bono & Stifter, 2003; Montague & Walker-Andrews, 2002) and strangers (Hobson et al., 2004; Varghese, 2007). For example, mothers' amount of maintaining infants' attention was positively correlated with infants' focused attention in 18-month-old infants (Bono & Stifter, 2003). The authors argued that the results suggest links between maternal Maintaining Attention strategies in the common play interaction and infants' attentional abilities during problem-solving. Moreover, the parental involvement in the interaction with their 3.5-month-old infants was significantly correlated to infants' sensitivity when paying visual attention to the mothers' dynamic emotional expressions (i.e. happy, sad, angry) in a subsequent experiment (Montague & Walker-Andrews, 2002). Interestingly, the authors did not find these effects for the emotional expressions by infants' fathers and unfamiliar adults. In contrast, our results of increased infants' visual attention to the informants' emotional expressions also occurred with infants' fathers and unfamiliar adults as informants.

This could be due to the difference in the concrete measurement of infants' looking at the facial emotions. Whereas in Montague and Walker-Andrews's study, infants' visual sensitivity to different emotions was measured, we measured infants' visual attention to the informants across emotions. Additionally, other studies which also investigated infants' ability to accurately perceive others' emotions found positive effects between parents' sensitivity and infants' visual attention to unfamiliar adults (Varghese, 2007). Thus, parents' sensitivity seems to be consistently interrelated with infants' general visual attention to emotional information of a variety of informants. Remarkably, as suggested by another study, the validity of these positive interrelating effects to familiar and unfamiliar informants also exists for infants' joint engagement (Hobson et al., 2004). We also observed this positive interrelation for infants' joint engagement with infants' parents.

Finally, our findings are in line with the claims made by attachment-theory (Bowlby, 1969). In the first half of their second year of life (clear-cut-attachment phase), infants' exploration and control of their environment is affected by infants' feeling of certainty about their parents as a secure base. Since infants' expectations about their parents as a secure base are particularly shaped by the parents' sensitivity in the parent-infant interaction, it is possible that the positive interrelation between parents' sensitivity and infants' reception of information from familiar and even unfamiliar informants was based on these expectations. In that way, our results *highlight the importance of parents' sensitivity for infants' confidence to receive information about the world from familiar and unfamiliar social partners*. This supports our first hypothesis in terms of the assumed positive interrelation between parents' sensitivity and infants' information reception – the more that infants' signals will be taken into account by their social environment (mostly reflected by their parents), the more infants are willing to take the signals provided in their social environment into account. Possible reasons why we did not find such an effect for infants' use of others' emotional information were discussed in section 3.4.4.

4.4.2 Interrelations between Parents' Sensitivity and Infants' Selective Social Learning

Based on the imitation paradigm of Study 4b and the hiding-finding game of Study 4c, we investigated whether parents' sensitivity was interrelated with infants' preferences to informants' familiarity when choosing between familiar and unfamiliar informants. Thus far, to the best of our knowledge, no empirical study has provided evidence to answer this question, which reflects a considerable gap of research in the field of infants' selective social learning. One can imagine that parents' sensitivity is related to infants' willingness to choose their parents as reliable sources of information or not. We hypothesized a positive correlation between

parents' sensitivity and infants' preference to selectively receive information from their parents and to preferably use information provided by their parents – the more that infants' parents take infants' signals into account, the more infants are willing to take their parents' signals into account. However, we did not find effects between parents' sensitivity and infants' information reception and imitative behavior when the informants modeled an action (Study 4b). Thus, infants' selectivity when looking at and imitating modeled actions from familiar and unfamiliar informants was not related to parents' sensitivity. For a discussion about possible reasons for this lack of significant interrelations, see section 3.4.4. When infants looked for information about the location of a hidden object, and when infants were provided with referential cues as indications of the object's location, we obtained a significant pattern of results (Study 4c). Regarding information reception, infants of more sensitive parents had no preference for the familiar or unfamiliar informant, although we hypothesized that infants with more sensitive parents preferred to look for information from their parents rather than the experimenter. In contrast to infants of more sensitive parents, infants of less sensitive parents preferred to look for information from the unfamiliar rather than the familiar informant. This effect resulted in a significant difference concerning infants' information reception from parents: Infants of more sensitive parents looked for information from their parents more than did infants of less sensitive parents, which is in line with our hypothesis. This finding further supports the claims made by attachment theory, indicating that parents function as a secure base for infants' development and learning (Bowlby, 1969). Given this secure base, infants in their first year of life already develop a feeling of trust in their parents as secure support and reliable source of information for infants' social learning (pre-attachment and attachment-in-the-making phase). Through parent-infant interaction, infants form expectations about parents' reactions to their needs. These expectations are crucial in the development of trust in parents as reliable sources of information. Regarding infants' information reception from informants, we conclude that, in comparison to infants of less sensitive parents, infants of more sensitive parents expected their parents to be more reliable sources of information.

In accordance with the non-selectivity of infants of more sensitive parents and the selectivity of infants of less sensitive parents when receiving information from informants, this pattern also occurred in terms of infants' use of informants' referential cues. More specifically, whereas a significant number of infants of less sensitive parents showed selectivity in terms of the informants' familiarity by either following the referential cues of the familiar or the unfamiliar informant, the number of selective infants was not the superior number in the group of infants with more sensitive parents. The selectivity of infants of less sensitive parents did not result in

a significant preference for a certain informant, however, in direct comparison, infants of less sensitive parents followed their parents' referential cues more than infants of more sensitive parents did. This was contradictory to our second hypothesis, because when investigating the interrelation between parents' sensitivity and infants' preference for familiar versus unfamiliar informants, we expected to find mutuality, that infants of more sensitive parents would demonstrate preference for their parent rather than the experimenter as a source of information. However, regarding the paradigm in Study 4c, this would not be reasonable, since the informants' familiarity was not a relevant aspect of problem-solving (i.e. to find the hidden toy) in this situation. Both the familiar and the unfamiliar informant had visual access to the hiding of the object and, thus, had knowledge about the object's location. Therefore, in order to find the hidden object, there was no rational reason for a preference for either the familiar or the unfamiliar informant, raising the assumption about the importance of parents' sensitivity for infants' awareness in social learning situations, that is, the ability to focus on aspects which are relevant to solve problems by social learning.

4.4.3 Interrelations between Parents' Sensitivity and Infants' Consideration of Relevance

According to the assumption mentioned above, parents' sensitivity possibly supported infants' ability to focus on aspects that are relevant to the achievement of a current goal. This might be explained by infants' experiences with achieving their own goals and the support of autonomy when solving problems. In parent-infant interaction, we primarily observed the parental support of infants' activities and infants' focus of attention when playing with objects. Infants of more sensitive parents experienced less direction in common play and were instead assisted by their parents to solve the problems on their own (e.g. commenting rather than intervening when infants figured out which of the different-sized cups fit the other). Thus, infants of more sensitive parents were supported by their parents to learn what was relevant to solve a problem on their own, whereas infants of less sensitive parents experienced less support or even parent-directed interaction when trying to solve a problem. Accordingly, infants of more sensitive parents possibly perceived the experimental hiding-finding game, with the parent being present, as an assisted learning situation in which they could figure out what was relevant to solve the problem on their own. In contrast, infants of less sensitive parents possibly had less confidence that they could figure out what was relevant to solve the problem on their own, but were instead affected by the informants' familiarity (i.e. less information reception from their parents as opposed to infants of more sensitive parents, possibly reflecting their expectations

for less reliable parents; more use of parents' referential cues as opposed to infants of more sensitive parents, possibly reflecting their dependence on the parents' information). The parents' centering on infants' activities and focus of attention reflects a core aspect of parents' sensitivity: The capability of "perceiving things from [the child's] point of view" (Ainsworth et al., 1971, p. 43). This core capability requires the parents' readiness to change their own focus of attention in response to infants' current level of engagement (Meins et al., 2001). It is especially the sensitivity to infants' growth needs (e.g., self-actualization, that is, to pursue inner talent, creativity, or fulfillment, see Maslow, 1970) which reflects parents' understanding of infants as intentional agents with their own interests, motivations, and mental states (Fonagy et al., 1994; Meins, 1997; Meins et al., 2003; Meins et al., 2001). Accordingly, the concept of mind-mindedness (see Introduction, 1.4.1) was found to predict children's theory of mind development (Meins et al., 2002). This finding, in turn, might support our assumption about the positive interrelation of parents' sensitivity to infants' focus of attention and interests with infants' ability to focus on more relevant aspects when evaluating the informants' reliability. The more relevant aspect in our study were the informants' knowledge states, which were directly equal in Study 4c. Given the comparable knowledge state of both informants, the non-selective information use of infants with more sensitive parents in the hiding-finding game might indicate infants' ability to focus on aspects which are relevant to solve a problem by social learning. Whether infants' consideration of relevance in such a social learning situation is indeed interrelated with parents' sensitivity, this is a question that needs to be investigated in future research.

4.4.4 Conclusion

The previous discussion focused on the interrelation between the quality of parent-infant interaction and infants' social learning from familiar and unfamiliar informants. Our findings for infants' social referencing behavior support our first hypothesis and highlight the importance of parents' sensitivity for infants' confidence to receive information about the world from familiar and unfamiliar social partners. For infants' selective social learning, we observed a pattern of selectivity for infants of less sensitive parents, and, in contrast, a non-selective pattern for infants of more sensitive parents. This indicates that the processes going on between the quality of parent-infant interaction and infants' selective social learning are more sophisticated than expected by a mere mutuality of trust (as assumed by our second hypothesis). Given the knowledgeability of both informants in the hiding-finding paradigm, there was no rational reason to prefer the referential cues indicated by the familiar or the unfamiliar informant. This

result elicits a thesis concerning the importance of parents' sensitivity for infants' ability to focus on aspects which are relevant to solve a problem by social learning. Whether infants' consideration of relevance in such a social learning situation is indeed interrelated with parents' sensitivity needs to be investigated by future research.

4.5 Pedagogical Relevance

Developmental psychology serves as an important basis to accompany and support infants' development in pedagogical settings. Therefore, we address the question of transferring our results to pedagogical settings, which become especially relevant for infants in their second year of life. Since infants often experience the transition from their homes into institutions of public education and care not until the beginning of their second year of life in Westernized cultures, these settings are relatively unknown and ambiguous for infants. To get familiar with the new environments and people, it is relevant that infants receive information about them, which is often provided by unfamiliar teachers who are knowledgeable about the novel setting. In our studies, we investigated infants' ability to receive information from unfamiliar and familiar informants in unfamiliar and familiar settings by measuring infants' looking behavior at the informants. Infants' looking preference for the unfamiliar informant was consistent in all the studies that investigated this effect (i.e. Study 1a, Study 1b, and Study 3). The biggest effects of infants' looking behavior mostly occurred in terms of infants' looking time. The mean difference between the looking time at the unfamiliar informant and the looking time at the familiar informant was 15.8% of presentation time or 4.8 of 30.3 seconds ($\eta^2 = .460$) in Study 1a, a difference of 1.3% of demonstration time or 0.4 of 31.5 seconds ($\eta^2 = .125$) in Study 1b[51], and a difference of 5.2% of time or 0.5 out of 10 seconds ($r = 0.24$) for the 14-month-olds in Study 3. The effect sizes varied between the studies but the existence of the effect, that is, the preference for the unfamiliar informant, is very persistent. The mean difference between the looking times at the unfamiliar over the familiar informant across each of these studies does not seem to be very relevant (i.e. 7.4% of overall looking time). However, we do not know which cognitive processes take place during this time and, moreover, if we transfer it onto infants' everyday life, it might become important. For instance, based on a fictitious extrapolation, an infant, who starts to visit daycare at 14 months of age, is confronted with a variety of novel impressions reflecting an ambiguous situation for the infant (e.g., novel children, novel rooms,

[51] The small difference is mainly due to the low amount of looking at the models since in the demonstration phase of Study 1b, participants mostly paid attention to the demonstrated action itself rather than to the experimenter or the parent who modeled the action (see chapter 3.1.2).

novel objects and toys, novel routines). In this ambiguous situation, the teacher functions as an informant for the infant to provide information about the novel entities. Imagine that the infant interacts with an initially unfamiliar teacher for 4 hours per day, 5 days a week, and 20 days per month. Although infants get to know the teacher much better within this month, we assume that there still remains a core difference of familiarity compared to the infant's parent. Moreover, although the teacher likely does not directly interact with the infant all of the time, the teacher usually pays a lot of attention to the new infant, especially in the familiarization phase of the first weeks. During this time, the parent accompanies the infant to provide a secure base, which makes the example even more comparable to the current studies, in which the parent was present in addition to the unfamiliar informant. Assuming that daycare is an unfamiliar context for infants in the first month after the transition, it would be even more comparable to only use the mean difference of the laboratory data in our studies (i.e. 8.0% of overall looking time). Thus, in the first month, given the mean looking time difference of 8.0%, a 14-month-old infant would pay 6.4 hours (i.e. one and a half days of the familiarization phase) more attention to the unfamiliar teacher than they would to their parent. Thus, against the background of their parent's presence, infants seem to be well prepared to gather information from unfamiliar informants in novel settings and therefore to learn about and get familiar with a social environment that takes up more and more room in infants' everyday life. Note that the results of this and the following extrapolation should be taken as exemplary assumptions based on the data of the current studies and, therefore, have to be investigated empirically. We do not know, for example, whether infants' looking preference in our studies[52] will be a consistent pattern over 4 hours per day, on which we have based our projection of infants' looking preference for the unfamiliar informant in the first month of the familiarization phase in daycare.

Moreover, as we have already reported and discussed, there were significant interrelations between the quality of parent-infant interaction and infants' social learning behavior. One of these significant effects concerns the increased information reception of infants of more sensitive parents to both the familiar and the unfamiliar informant (see Study 4a, section 3.4.1). In order to demonstrate the pedagogical relevance of this mean difference, we have designed a fictitious extrapolation as in the previous example. The mean looking time at the unfamiliar informant was 52.4% of the overall looking time for infants of more sensitive parents, and 40.4% of the overall looking time for infants of less sensitive parents (mean difference of 12.0%). The mean looking time at the familiar informant was 35.7% of the overall looking time

[52] The overall time in which we measured infants' looking behavior was approximately 5 minutes per infant for Study 1a, Study 1b, and Study 3 together.

for infants of more sensitive parents, and 20.7% of the overall looking time for infants of less sensitive parents (mean difference of 15.0%). Thus, infants of more sensitive parents looked 27.0% more of the time at both familiar and unfamiliar informants than infants of less sensitive parents. In the first month of daycare, infants of more sensitive parents would receive more information from both informants for 21.6 hours per month (i.e. more than 5 days or 1 week of the familiarization phase), than infants of less sensitive parents. Regarding the speed of infants' social-cognitive processes when learning about the world, one can imagine that about 25% of the familiarization time provides a good basis for infants to gather important information from both informants about the novel environment. Therefore, infants seem to experience a great benefit from sensitive parent-infant interactions when learning from familiar and unfamiliar adults. Consequently, the current findings refer to the importance of a parent's sensitivity for infants' social learning behavior. This further legitimizes parent training to support their potential for interaction in a highly sensitive way concerning infants' signals and needs. Such training was even found to improve the development of infants' brain structure in preterm infants (Milgrom et al., 2010). Furthermore, it would be interesting to check whether the interrelation of the parents' sensitivity in the parent-infant interaction with infants' social learning processes also exists in terms of the interaction between a pedagogical educator and infants in institutions of public education and care. There is already evidence highlighting the importance of the pedagogical educators' sensitive responsiveness in daycare facilities (Remsperger, 2011). It would be interesting to know whether these effects could also be found for the aspects of parents' sensitivity measured in the current dissertation, that is, Maintaining Attention and Warm Sensitivity.

In the following we provide further claims of a pedagogical relevance of our current findings. Referring to our results of infants' understanding and use of others' referential cues, we suggest that especially when communicating with infants at the beginning of their second year of life, it seems to be more appropriate to use concrete referential cues (e.g. pointing gestures) than abstract referential cues (e.g. physical objects). Moreover, based on our findings in terms of infants' ability to use others' knowledge states, it is also important to point out that infants at 14 months of age in particular still have difficulties evaluating an informant's reliability based on her/his knowledge state in order to use the provided information for their own behavior regulation when infants themselves lack this knowledge. Thus, to avoid the risk of misleading the social learning behavior of infants at this age with irrelevant information, we would advise only providing knowledge when one is knowledgeable and therefore able to provide relevant information.

Finally, although infants preferred to receive information from the unfamiliar rather than from the familiar informant in our social learning situations, infants nevertheless considered both informants by paying visual attention to the familiar and unfamiliar informant while they provided information (see section 3.1 and 3.3 for corresponding data). Moreover, infants' exploratory behavior, imitative behavior, and their use of referential cues was not restricted to only a familiar or an unfamiliar informant. Instead, infants explored the boxes in at least 2/3 of exploration time regardless of who presented the boxes (Study 1a), imitated the modeled action from both informants and generally in almost 2/3 of trials (Study 1b), and followed the referential cues to the location of a hidden object even from unfamiliar adults (Study 2a, Study 2b, Study 3). From this perspective, infants seem to be well prepared for the transition from their homes to institutions of public education and care that consist of everyday life with a new proportion of contact to their parents and unfamiliar teachers, familiar and unfamiliar environments.

4.6 A Reliability Model as Impetus for Future Directions

4.6.1 Infants' Ongoing Evaluation of Informants' Reliability

The current dissertation generated new results about infants' selective social learning on the one hand, and it produced several new questions and assumptions about the interpretation of these results on the other hand. In this final chapter of the General Discussion our concern is to combine the main results and assumptions of this dissertation in order to create an overall picture of our empirical evidence and, with it, to provide structured impetuses for the field of research on infants' selective social learning.

The starting point of this overall picture is reflected by one of our remarkable results, that is, the gap between infants' preference to receive information from unfamiliar informants and the lack of preference for a certain informant in infants' information use. More specifically, whereas infants looked first and looked longer at, and showed more joint engagement with the unfamiliar rather than the familiar informant regardless of the location and the paradigm, infants did not show consistent selectivity to a certain informant in their exploratory (Study 1a), imitative (Study 1b), or object-search behavior (Study 3). Thus, the pattern of infants' information reception was different from the pattern of infants' information use. This gap between receiving and using information indicates that something must have affected infants' selectivity to informants in between. One explaination of this gap refers to the reliability research on infants' selective social learning (Buttelmann et al., 2013; Chow et al., 2008; Koenig & Echols, 2003;

Koenig & Sabbagh, 2013; Poulin-Dubois et al., 2011; Ryalls et al., 2000; Zmyj et al., 2010; Zmyj et al., 2012; see Harris & Lane, 2013; Lucas & Lewis, 2010 for reviews; see Introduction, section 1.1.3). This research field suggests that infants select certain informants whom they perceive to be more reliable than other informants and, thus, to be more relevant to the achievement of their current goal. Accordingly, we developed a *model of infants' ongoing evaluation of informants' reliability* (see Figure 38).

Based on this model, infants' looking preference at the unfamiliar informant when receiving information in our studies suggests that infants *spontaneously ascribe reliability* to the unfamiliar informant. We assume this ascription to be spontaneous due to the temporal component, meaning that infants' looking behavior in all of the studies was the first measurement in the social learning tasks and, thus, the first behavior of infants related to the informants' information. As demonstrated in Study Set 1 and the corresponding discussion, infants' spontaneous ascription of reliability cannot be explained by the local-expertise hypothesis, which might be due to the amount of inferential steps necessary to infer the knowledge state of the local expert about the concrete objects and actions. Moreover, as we have discussed in a previous section (4.3.1), infants' spontaneous ascription of reliability cannot sufficiently be explained by the unfamiliar informants' novelty alone. Instead, it is possible that infants ascribe an object-expertise or action-expertise to the experimenter, possibly in conjunction with the perception of the experimenter as the more confident informant in the experimental learning situations. This hypothesis should be investigated in future research.

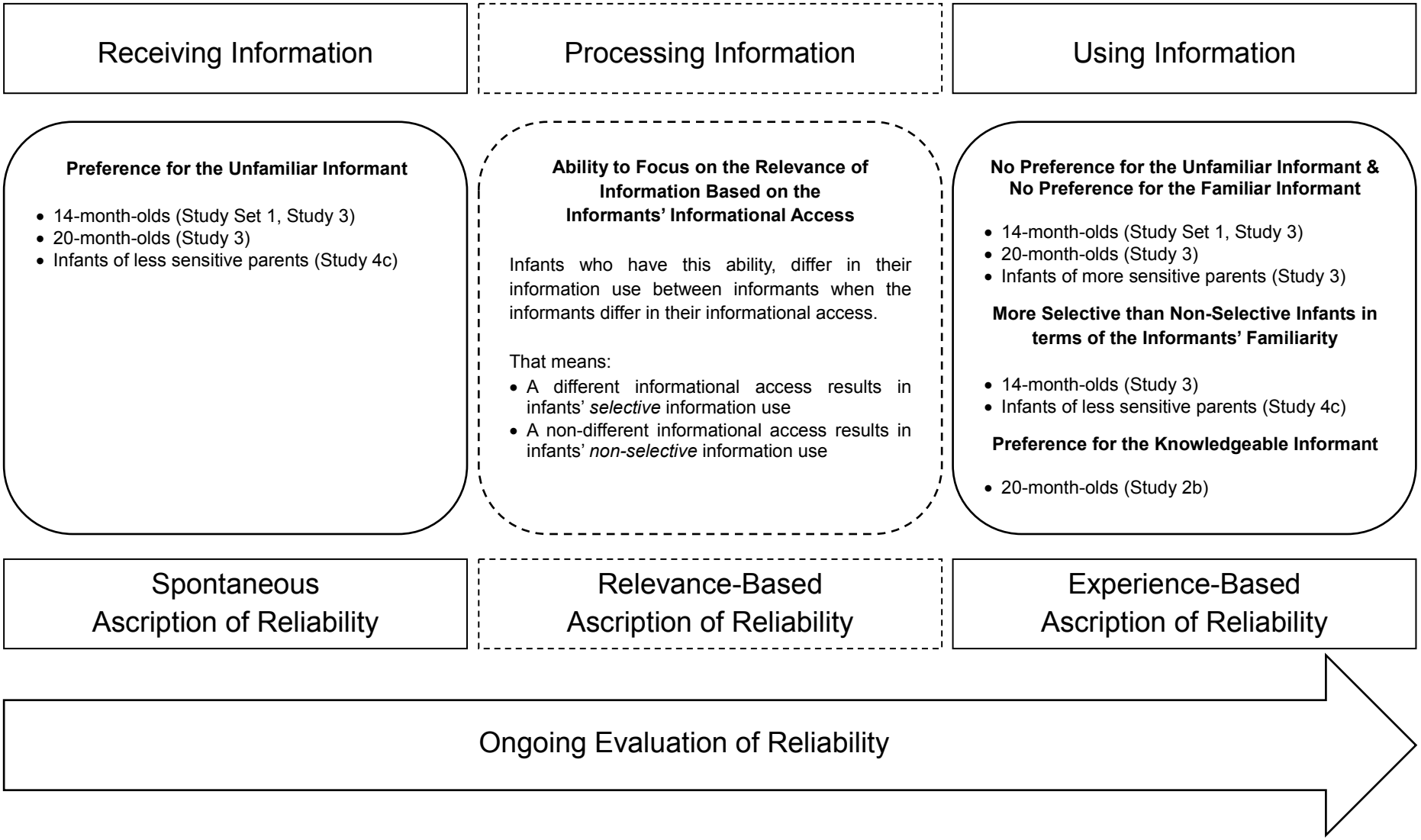

Figure 38. The model of infants' ongoing evaluation of informants' reliability. The model displays the process of infants' ongoing evaluation of informants' reliability based on the main results of the four study sets.

In contrast to infants' spontaneous ascription of reliability to the experimenter when receiving information, infants did not show a preference for a certain informant when using information provided by familiar and unfamiliar informants. Assuming that infants use information based on their current ascription of reliability to the informants, we conclude that infants obviously did not perceive one informant as more reliable than the other. Following Harter and Aine (1984, p. 293), selectivity is defined as "the predisposition of an organism to process the selectively relevant, as compared to irrelevant, environmental information". Therefore, it is possible that infants did not perceive one informant as more relevant than the other to the solving of a problem in our social learning tasks. Remarkably, the informants' familiarity in our studies was an aspect that was irrelevant to learning about the valence of a novel object (Study 1a), to learning about how to perform a novel action (Study 1b), and to getting knowledge about the location of a hidden object (Study 3). In other words, in each of the studies, the informants' familiarity had no impact on the relevance of the provided information. Against this background, the difference between infants' spontaneous ascription of reliability to the unfamiliar informant when receiving information and the lack of preference for a certain informant when using information leads us to assume an ongoing ascription of reliability in between the reception and use of information. According to information-processing theories, all received information that is subsequently used will be processed in the meantime (Lachman, Lachman, & Butterfield, 1979). Rather than processing all the information, infants already demonstrate selectivity by focusing on the information that is most relevant for the current aim (Campbell, Hayne, & Richardson, 2014). Therefore, we suggest a *relevance-based ascription of reliability* when processing information, indicating that infants in this phase estimate the relevance of information based on the informants' informational access. Whether or not an informant has access to information determines whether s/he possess relevant information about a current aim. The informants' informational access has to be inferred by infants. We assume this inference to be an important ability in estimating the relevance of information and, based on this, ascribing reliability to informants.

We claim that there are differences in the directness of inferring the informational access, meaning that a more direct informational access (e.g. an informant's visual access) requires fewer cognitive steps to infer an informant's informational access. In contrast, a more indirect informational access (e.g. an informant's local expertise) requires more cognitive steps in order to infer an informant's informational access. In our studies, the informants' informational access was not directly different in Study Set 1, however, it was directly non-different in Study 3 (i.e. both informants had visual access), and directly different in Study Set 2 (i.e. one informant had

visual access, the other informant had no visual access). Regardless of the directness, the main aspect of this ability is to recognize whether or not the informants differ in terms of their informational access. We surmise that infants who have this ability differ in their information use between the informants whenever the informants differ in their informational access, and we surmise that infants who have this ability do not differ in their information use between the informants whenever the informants do not differ in their informational access. These assumptions arose based on the overall picture of our study results, and we suggest that more research should be undertaken in order to investigate whether these assumptions are also a valid explanation of infants' selective social learning behavior in future studies.

Our findings provide evidence for possible factors that shape infants' ability to focus on informants' informational access. One factor that might improve this ability turned out to be the infants' age. Infants at 20 months of age differed in their use of information between the informants when the informants differed in their informational access (i.e. preference for the knowledgeable informant having visual access, Study 2b), however, they did not differ in their information use between the informants when the informants had an equal and thus non-different informational access (i.e. no selectivity due to the informants' familiarity, Study 3). In contrast, infants at 14 months of age did not differ in their information use between informants although informants differed in their informational access (i.e. no preference for the knowledgeable informant having visual access, Study Set 2), but they did differ in their information use between informants although the informants had equal and thus non-different informational access (i.e. general selectivity due to the informants' familiarity, Study 3). The influence of the informants' familiarity was indicated by the significant number of infants at 14 months of age who either selectively followed the referential cues of the familiar or the unfamiliar informant in Study 3. This vulnerability to the informants' familiarity for infants at 14 months age was also supported by the results of Study 1a (more exploration when familiar informant presented the box) and Study 1b (spontaneously imitated the familiar informant more). These results suggest that infants at 14 months of age do not yet possess the ability to estimate the relevance of information based on the informational access of informants, whereas infants at 20 months of age showed evidence of this ability. Thus, we assume infants' age to have an impact on infants' ability to focus on the informants' informational access when solving a problem in a concrete learning situation and therefore to ascribe reliability to informants based on the relevance of their information. This claim is supported by the developmental account of infants' information gathering (Baldwin & Moses, 1996), suggesting that the capacity to focus on and actively seek information from others arises within infants' second year of life and is

affected by the developing ability to perceive oneself and others as individuals with knowledge and information.

Moreover, another factor shaping this ability might be the quality of parent-infant interaction, in particular, the parents' sensitivity, which was interrelated with the selectivity due to the informants' familiarity. That is, whereas infants of more sensitive parents did not differ in their information use between familiar and unfamiliar informants when the informants had a non-different informational access, (i.e. no selectivity due to informants' familiarity, Study 4c), a significant number of infants of less sensitive parents differed in their information use between the informants although the informants had a non-different informational access (i.e. selectivity due to informants' familiarity, Study 4c). This leads us to assume that infants' ability to focus on the informants' informational access when evaluating the informants' reliability might be supported by parents' sensitivity in the parent-infant interaction. Both of these assumptions – the impact of infants' age on, as well as of the interrelation of parents' sensitivity with infants' ability to focus on the relevance of information based on the informants' informational access when ascribing reliability to informants in a social learning situation – should be investigated in future research.

Given the gap between infants' preferences when receiving and using information, we assume that infants' information use based on the current ascription of informants' reliability is more affected by the relevance-based ascription of reliability than by the spontaneous ascription of reliability. Moreover, we assume that infants' use of information itself is a part of the ongoing evaluation of the informants' reliability. When infants act upon the provided information, they usually experience the consequences of using this information. These consequences provide feedback in terms of the relevance of the information used and thus enable infants' *experience-based ascription of reliability*. Depending on whether the information turns out to be relevant or not, this experience further shapes the current ascription of the informants' reliability, as shown in several reliability studies mentioned at the beginning of this chapter. Complementary to those studies investigating infants' evaluation based on the previously experienced informants' reliability, we focused on infants' ascription of reliability even prior to an experience-based ascription. This essential extension revealed remarkable insights, which suggest that the evaluation of reliability is more finely graded than previously expected. Based on our model, the *ongoing evaluation of informants' reliability* includes a spontaneous ascription of reliability when receiving information, a relevance-based ascription of reliability when processing information, and an experience-based ascription of reliability when using information.

4.6.2 References to the Rational Inference Account

Our model of infants' ongoing evaluation of informants' reliability is in line with an account that suggests that children's evaluation of others' reliability is based on a process of rational inference (Sobel & Kushnir, 2013). The authors argue that children use their existing conceptual knowledge of the physical and social world to determine the informants' reliability. This knowledge allows them to make inferences about the reliability of informants even prior to any experience about the informants' accuracy. Thereby, children focus on factors of informants and the world that are relevant to determining reliability. More specifically, to interpret an informant's reliability, the authors argue, children take situational factors into account that potentially influence the informant's access to particular information, which, in turn, affects whether an informant can provide relevant information (see Einav & Robinson, 2011; Nurmsoo & Robinson, 2009). This decidedly refers to our model claiming infants' ability to focus on the informants' informational access when estimating the relevance of information. According to the rational inference account, infants' ability to focus on the informational access of informants reflects infants' use of their own conceptual knowledge when evaluating informants' reliability. That is, infants who possess this ability need to possess knowledge about the consequences of situational factors like the informants' visual perspective in our hiding-finding game. If infants have no knowledge about the equation "seeing-leads-to-knowing" (Baron-Cohen & Goodhart, 1994, p. 397), infants are not able to selectively ascribe different levels of informational access to informants and, thus, to differ in their ascription of reliability. This reflects an ascertainment of our model based on the rational inference account, leading us to assume that infants in the phase of the relevance-based ascription of reliability make inferences about others' reliability based on their own conceptual knowledge about situational factors in the world affecting others' informational access.

By referring to studies investigating children's knowledge about the effects of situational factors on others' informational access (Kuhn, Cheney, & Weinstock, 2000; Perner, 1991; Wellman & Liu, 2004), the authors of these studies claim that between the age of 3 and 5, children begin to explicitly take others' knowledge into account as subjective epistemic states. Although there had been no evidence for infants up to this point, Sobel and Kushnir (2013) expected this ability to develop during the second year of life, based on infants' statistical learning capacities (Haith, 1993; Kirkham, Slemmer, & Johnson, 2002) influencing infants' interpretation of causal information (Sobel & Kirkham, 2006, 2007). They even speculated an emergence of this ability at around 12 to 14 months of age. Although we did not find evidence for this ability in our 14-month-olds, we did so for infants at 20 months of age and, thus, can

confirm the assumption made by Sobel and Kushnir (2013) that this ability likely develops within infants' second year of life. Our results suggest that infants in the second year of life already demonstrate the first tendencies of a rational evaluation of informants by considering whether informants possess relevant information. The ability of rational decisions in social learning situations, as shown by studies mentioned above, further develops during childhood, resulting in an increased rationality of elementary schoolers, who already prefer probabilistic over irrelevant information in their decision making process when searching for and using information (Betsch & Lang, 2013; Betsch, Lehmann, Lindow, Lang, & Schoemann, 2016).

Besides the children's age, the authors also referred to another gap in research by suggesting that future studies should focus on the process while infants learned from others, which would give further insight to the online inferential processes when evaluating others' reliability. They particularly suggested investigating participants' visual attention to measure how participants process information from informants over time. This is exactly what we have done in the current dissertation and what has allowed us to provide more detailed evidence about the processes that were going on between infants' information reception and use, and it finally enabled us to detect the flexibility of infants' evaluation of informants' reliability. That is, in addition to studies that have already claimed children's flexible adjustments to changes in the accuracy of informants when ascribing reliability (Corriveau, Kinzler, & Harris, 2013; Jaswal & Neely, 2006), we could further show that infants are even flexible within the process of ascribing reliability to informants in advance of any reliability experiences with this informant. This leads to an assumption of an ongoing process of ascribing reliability to informants based on a rational inference both in advance and interacting with infants' experiences about an informants' reliability.

That children's inferences about reliability cannot be explained by mere associative learning is indicated by many studies of infants' selective social learning, such as in studies showing children's selective generalizations of others' expertise (Koenig & Jaswal, 2011; Sobel & Corriveau, 2010). Instead, the rational inference account is in line with theories of selective trust, in particular with the social learning theory focusing on infants and children as active seekers of knowledge in a social environment (Bandura, 1971), and recent theoretical accounts of selective trust focusing on children's use of others' actions and knowledge when evaluating their reliability (Harris & Corriveau, 2011; Koenig, 2012). Given the high accordance with the rational inference account and the complementary interpretations of the cognitive mechanisms playing a role when infants' evaluate others' reliability, we assume our model to be in line with these theories on a similar level.

4.6.3 References to the Organon Model

At the beginning of this dissertation we introduced the Organon model in order to illustrate the process of information transfer from informants to recipients. In the following, we finally adapt the Organon model in terms of the core knowledge and assumptions we received based on our results (see Figure 39). In our studies, we investigated infants' information reception and use from informants who differed in their familiarity and knowledge states. The incorporation of our main results in a model of infants' ongoing evaluation of informants' reliability uncovered possible mechanisms taking place when infants learn from others. In our model, we suggest a spontaneous ascription of reliability during infants' information reception and an experience-based ascription of reliability during infants' information use. In between these processes we suggest a *relevance-based ascription of reliability during infants' information processing*. Although infants already select reliable informants around their first birthday (see section 1.1.3), we suggest that the criteria by which infants decide whether to evaluate informants as reliable sources of information change in favor of a rational evaluation within infants' second year of life. We assume this rational evaluation to be an ability by which recipients focus not only on whether or not the informants have information, but rather focus on informants' possession of *relevant information*. The relevance of information in a social transfer of information is, for example, determined by the informants' informational access. The ability to focus on relevant information is important to enable an efficient and successful transfer of information and knowledge from informants to recipients.

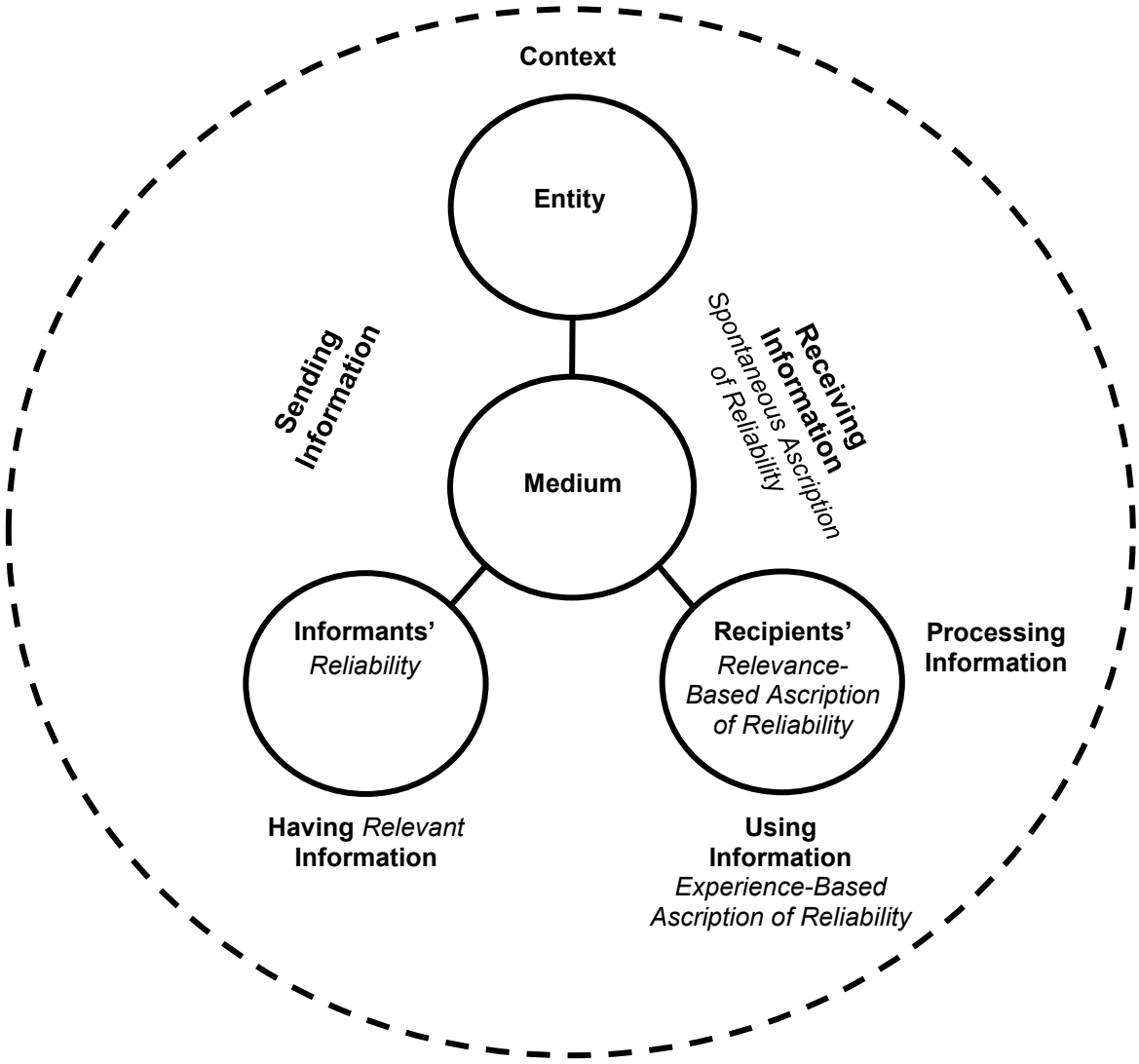

Figure 39. The adapted Organon model based on the main results of our studies.

4.7 Future Research

In this dissertation, we mentioned several suggestions for future studies. These suggestions are based, for example, on the open questions concerning infants' underlying motivation behind their looking preference for unfamiliar informants – it remains a challenge to conclusively rule novelty out as an alternative explanation and to investigate the suggested object-expertise or action-expertise hypothesis. Another open question concerns infants' ability to selectively use the informants' knowledge states. We discovered this ability in our 20-month-old participants by manipulating informants' knowledge states between subjects. Taking our results into consideration, future studies could focus on the developmental onset of a flexible use of the informants' knowledge states when infants are confronted with knowledgeable and ignorant informants at the same time.

The core impetus for future directions in this field of research, however, is based on the model of infants' ongoing evaluation of informants' reliability, reflecting an innovative way of explaining and incorporating our results and interpretations previously discussed. This is a task for continuing investigations of the validity of this model and its assumptions about the nature and development of infants' ability to focus on the informants' informational access as a relevant aspect of ascribing reliability to informants in a social learning situation. At the same time, studies should investigate whether the infants' age and the parents' sensitivity are indeed factors shaping the development of this ability within and beyond infants' second year of life. Moreover, it is an open question whether the chronology of the evaluation process –infants' relevance-based ascription takes place between their spontaneous ascription and their experience-based ascription of reliability – indeed proceeds in such a strict sequence or whether infants' focusing on informants' informational access in a learning situation, for example, can already take place at the beginning of the situation. In any event, it is possible that the single processes in the model do not strictly follow one another, but that there is a fluent transition between the different phases of ascribing reliability to informants. Another question to the model concerns the sensitivity of the infants' spontaneous ascription of reliability. One could expect that infants' spontaneous ascription of reliability in a later sequence of a social learning situation changes in accordance with the relevance-based and experience-based ascription of reliability in an earlier sequence. Furthermore, we claimed differences in our studies in terms of the directness of the informational access (i.e. more directly different in Study Set 2 and Study 3 compared to Study Set 1). We predicted a less direct difference of informational access between the informants to require more inferential steps in order to comprehend the informants' access to information. This could explain why participants of Study Set 1 were not selective in

their information use, since the local expertise of an informant reflected a more indirect difference in the informants' informational access. However, future studies should address whether the directness of the informational access indeed affects infants' ability to recognize the informational access of informants and thus to selectively use their information. These and further aspects should be considered in future research to confirm whether the suggested model is a valid concept for further clarifying the processes of infants' selective social learning. To do so, future studies could make use of a hiding-finding paradigm that turned out to provide remarkable potential in investigating infants' selective social learning in the second year of life. In addition to this, it would be interesting to examine the validity of the model in various paradigms including different mediums with, and entities about which information will be transferred from differently reliable informants to infants as recipients of differently relevant information. Consequently, the current dissertation in general, and the model of infants' ongoing evaluation of informants' reliability in particular, provides important new impetuses to the research field of infants' selective social learning, and it inspires further research in order to develop a deeper understanding of infants' behavior and underlying motivation when selecting certain informants to learn about the world.

5. Conclusion

In the following, we draw seven conclusions based on the results of the four study sets investigating the impact of the informants' knowledge states and familiarity on, as well as the interrelation between the quality of parent-infant interaction with, the selective social learning of infants in their second year of life:

(1) For infants' social learning behavior at 14 months of age, the local-expertise hypothesis is decidedly challenged by the results of this dissertation including familiar and unfamiliar informants and locations.
(2) Infants' selective use of informants' knowledge states based on the informants' visual perspective develops within the second year of life.
(3) Infants' ability to use a physical marker as an abstract referential cue develops within the second year of life, whereas infants' ability to use others' pointing gesture as a concrete referential cue is consistent within the second year of life.
(4) Infants at 14 and 20 months of age are consistently selective when receiving information from informants who differ in familiarity, that is, they prefer to look at unfamiliar rather than familiar informants in social learning situations.
(5) Infants are selective in terms of the informants' familiarity when using their information at 14 months of age but not at 20 months of age. However, none of the age groups show a consistent selectivity for a certain informant when using the informants' information.
(6) Infants of more sensitive parents receive more information from both familiar and unfamiliar informants than infants of less sensitive parents.
(7) Infants of more sensitive parents are not selective in terms of informants' familiarity when solving a problem by social learning, whereas infants of less sensitive parents are.

We finally suggest a model of infants' ongoing evaluation of informants' reliability including the reception, processing, and use of information. A core feature of this continuous process is infants' ability to focus on the relevance of information when solving a problem in a social learning situation. We assume this ability to be determined by infants' age and, potentially, to be interrelated with parents' sensitivity. The model incorporates the main results of our empirical findings providing new inspiration for the research field of infants' selective social learning. In this sense, the conclusion of this dissertation is the beginning of further research to provide more insight into the ontogenetic origins of knowledge transfer from one human generation to another and therefore more insight into the fundament of maintaining, passing on, and further developing human culture.

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List of Abbreviations

MA…… Maintaining Attention

WS…….Warm Sensitivity

MAWS…...Maintaining Attention & Warm Sensitivity

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Appendix A: Early Childhood Behavior Questionnaire (ECBQ) - German Version

Early Childhood Behavior Questionnaire (ECBQ)

Fragebogen zum Verhalten im Kleinkindalter

Name: _____

Geburtsdatum des Kindes : _____
Tag Monat Jahr

Datum _____

Alter des Kindes : _____ _____
Jahre Monate

Beziehung zum Kind:_____

Geschlecht des Kindes:
☐ m ☐ w

Instruktionen

Vor dem Ausfüllen die bitte sorgfältig durchlesen !

Auf den nächsten Seiten sind mögliche Verhaltensweisen von Kleinkindern beschrieben. Kreuzen Sie bitte an, wie oft Sie dieses Verhalten während der LETZTEN ZWEI WOCHEN beobachtet haben, und markieren Sie die entsprechende Zahl rechts hinter der jeweiligen Textzeile.

nie	sehr selten	weniger als d. Hälfte	ungefähr die Hälfte	mehr als die Hälfte	fast immer	immer	trifft nicht zu
1	2	3	4	5	6	7	X

1	2	3	4	5	6	7	X

Die Zahlen geben an, wie oft Sie dieses Verhalten während der letzten zwei Wochen bei Ihrem Kind beobachtet haben.

Die „Trifft nicht zu“ (X)-Spalte markieren Sie, wenn Sie Ihr Kind während der letzten zwei Wochen nie in der beschriebenen Situation beobachtet haben. Wenn zum Beispiel beschrieben wird, dass Ihr Kind zum Arzt ging und Sie in den letzten zwei Wochen nicht beim Arzt waren, markieren Sie (X).

„Trifft nicht zu“ unterscheidet sich von „Nie“(1).

„Nie“ wird gebraucht, wenn Sie Ihr Kleinkind in der Situation beobachtet haben, es aber keine der unten stehenden Verhaltensweisen während der letzten Woche gezeigt hat.

Bitte achten Sie darauf, für JEDE FRAGE eine Zahl oder das X zu markieren.

nie	sehr selten	weniger als die Hälfte	ungefähr die Hälfte	mehr als die Hälfte	fast immer	immer	trifft nicht zu
1	2	3	4	5	6	7	X

		1	2	3	4	5	6	7	X
	Wenn sich Ihrem Kind eine unbekannte Person in der Öffentlichkeit genähert hat (z. B. im Supermarkt); wie oft hat Ihr Kind:								
1	sich an ein Elternteil geklammert?	1	2	3	4	5	6	7	X
	Wenn Ihr Kind Schwierigkeiten hatte, etwas fertig zu machen (z.B. bauen, malen, anziehen); wie oft ist Ihr Kind:								
2	schnell gereizt geworden?	1	2	3	4	5	6	7	X
	Wenn ein bekanntes Kind zu Ihnen nach Hause kam; wie oft hat Ihr Kind:								
3	die Gesellschaft des anderen Kindes gesucht?	1	2	3	4	5	6	7	X
	Wenn Ihrem Kind eine Auswahl an Aktivitäten angeboten wurde; wie oft hat es:								
4	sehr schnell entschieden und diese Wahl verfolgt?	1	2	3	4	5	6	7	X
	Während ruhiger Zeiten am Tag oder am Abend mit Ihnen; wie oft hat Ihr Kind:								
5	es genossen, wenn ihm leise vorgesungen wurde?	1	2	3	4	5	6	7	X
	Wenn es draußen gespielt hat; wie oft hat Ihr Kind:								
6	gewählt ein Risiko einzugehen wegen des Spaßes und der Aufregung?	1	2	3	4	5	6	7	X
	Wenn es mit seinem Lieblingsspielzeug spielte: wie oft hat Ihr Kind:								
7	mehr als 10 Minuten gespielt?	1	2	3	4	5	6	7	X
8	weitergespielt und gleichzeitig auf ihre Fragen oder Bemerkungen reagiert?	1	2	3	4	5	6	7	X
	Wenn ihm erzählt wurde, dass geliebte Erwachsene zu Besuch kommen; wie oft hat Ihr Kind:								
9	sehr aufgeregt reagiert?	1	2	3	4	5	6	7	X
	Bei ruhiger Beschäftigung wie beispielsweise beim Vorlesen eines Buches; wie oft hat Ihr Kind:								
10	an seinen Kleidern, Haaren, etc. herum gespielt?	1	2	3	4	5	6	7	X
	Wenn es drinnen spielte; wie oft:								
11	hatte Ihr Kind keinen Spaß an rauen u. wilden Spielen?	1	2	3	4	5	6	7	X
	Wenn Ihr Kind sanft geschaukelt oder umarmt wurde; wie oft:								
12	schien es erpicht darauf, weg zu kommen?	1	2	3	4	5	6	7	X
	Beim Kennenlernen einer neuen Aktivität; wie oft:								
13	ist Ihr Kind sofort involviert gewesen?	1	2	3	4	5	6	7	X
	Wenn es vertieft war in eine Beschäftigung, die Aufmerksamkeit benötigte, wie z. B. bauen mit Klötzen; wie oft hat Ihr Kind:								
14	die Beschäftigung schnell gewechselt?	1	2	3	4	5	6	7	X
	Bei Alltagsbeschäftigungen; wie oft:								
15	hat Ihr Kind sofort aufmerksam reagiert wenn Sie es gerufen haben?	1	2	3	4	5	6	7	X
	In Alltagssituationen; wie oft hat Ihr Kind:								
105	irritiert von Wäschezeichen in seinen Kleidern?	1	2	3	4	5	6	7	X
17	sich bei lauten Geräuschen erschreckt (z.B. Feuerwehrsirene)?	1	2	3	4	5	6	7	X

nie	sehr selten	weniger als die Hälfte	ungefähr die Hälfte	mehr als die Hälfte	fast immer	immer	trifft nicht zu
1	2	3	4	5	6	7	X

		1	2	3	4	5	6	7	X
Wie oft hat Ihr Kind im Alltag:									
18	volle Energie gewirkt, sogar am Abend?	1	2	3	4	5	6	7	X
Wie oft reagierte Ihr Kind in der Öffentlichkeit:									
19	scheinbar ängstlich vor großen, lauten Fahrzeugen?	1	2	3	4	5	6	7	X
Wenn Ihr Kind draußen mit anderen Kindern spielte; wie oft:									
20	schien es eines der aktivsten Kinder zu sein?	1	2	3	4	5	6	7	X
Wenn Sie ‚Nein' sagten; wie oft hat Ihr Kind:									
21	mit der verbotenen Aktivität aufgehört?	1	2	3	4	5	6	7	X
22	angefangen zu weinen, weil es traurig wurde?	1	2	3	4	5	6	7	X
Nach einem aufregenden Ereignis oder Aktivität; wie oft:									
23	schien Ihr Kind unglücklich oder deprimiert?	1	2	3	4	5	6	7	X
Wenn es drinnen spielte; wie oft:									
24	rannte Ihr Kind durch das Haus?	1	2	3	4	5	6	7	X
Vor einem aufregenden Ereignis (wie beispielsweise vor einem neuen Spielzeug); wie oft:									
25	war Ihr Kind sehr aufgeregt, es zu bekommen?	1	2	3	4	5	6	7	X
Wenn Ihr Kind etwas wollte und Sie ‚nein' sagten; wie oft:									
26	bekam es einen Wutanfall?	1	2	3	4	5	6	7	X
Wenn Ihr Kind auf etwas Gewünschtes warten mußte (wie z.B. Eiskrem); wie oft:									
27	wartete es geduldig?	1	2	3	4	5	6	7	X
Wenn Ihr Kind hin und her gewiegt wurde; wie oft:									
28	lächelte es?	1	2	3	4	5	6	7	X
Wenn Sie Ihr Kind auf dem Schoss hielten; wie oft:									
29	schmiegte es sich an Ihren Körper an?	1	2	3	4	5	6	7	X
Wenn eine bekannte erwachsene Person, wie z.B. Verwandte oder Freunde Sie zuhause besuchte; wie oft wollte Ihr Kind:									
30	mit der Person interagieren?	1	2	3	4	5	6	7	X
Wenn Sie Ihr Kind baten; wie oft war es in der Lage:									
31	mit etwas Zerbrechlichem vorsichtig umzugehen?	1	2	3	4	5	6	7	X
Wenn Sie einen neuen Ort besuchten; wie oft wollte Ihr Kind:									
32	nicht mit hinein gehen?	1	2	3	4	5	6	7	X
Wenn Ihr Kind über etwas aufgebracht war; wie oft:									
33	weinte es länger als 3 Minuten, obwohl es getröstet wurde?	1	2	3	4	5	6	7	X
34	ließ er/sie sich schnell beruhigen?	1	2	3	4	5	6	7	X
Wenn Sie beschäftigt waren; wie oft fand Ihr Kind:									
35	eine andere Aktivität, wenn Sie es dazu ermunterten?	1	2	3	4	5	6	7	X
Wenn Ihr Kind in einer größeren Ansammlung bekannter Erwachsener oder Kinder war; wie oft:									
36	hatte es Spaß daran, mit unterschiedlichen Personen zu spielen?	1	2	3	4	5	6	7	X

Vielen Dank für Ihre Mitarbeit

Appendix B: Parenting Style Questionnaire - German Version

Fragebogen zum Erziehungsstil

Lesen Sie sich die folgenden Fragen zu Ihrem Erziehungsstil sorgfältig durch und beantworten Sie sie dann möglichst spontan. Es gibt keine richtigen oder falschen Antworten.

		Trifft gar nicht zu	**Trifft eher nicht zu**	**Trifft eher zu**	**Trifft genau zu**	
1.	Ich gebe meinem Kind ein Gefühl von Wärme und Geborgenheit.	O	O	O	O	L +
2.	Es ist wichtig, dass Kinder lernen, Autoritäten anzuerkennen.	O	O	O	O	S +
3.	Ich finde es falsch, wenn Kinder die Entscheidung ihrer Eltern in Frage stellen.	O	O	O	O	S +
4.	Ich achte darauf, dass mein Kind selbst die Verantwortung für sein/ihr Leben übernimmt.	O	O	O	O	E +
5.	Mein Kind weiß genau, dass ich sehr stolz auf ihn/sie bin.	O	O	O	O	L +
6.	Ich finde es richtig, wenn Eltern ihren Kindern nicht alles durchgehen lassen.	O	O	O	O	S +
7.	Ich bin mir sicher, dass mein Kind mich liebt.	O	O	O	O	L +
8.	Auch in schwierigen Phasen empfinde ich immer eine tiefe Zuneigung zu meinem Kind.	O	O	O	O	L +
09.	Ich bin stolz auf das was mein Kind tut.	O	O	O	O	L +
10.	Ich finde es richtig, wenn Eltern ein Kind, das nie hört, bestrafen.	O	O	O	O	S +
11.	Auch über schwierige Themen wird bei uns ganz offen gesprochen.	O	O	O	O	E +
12.	Ich bemühe mich, meinem Kind so viel Liebe und Wärme wie möglich zu geben.	O	O	O	O	L +
13.	Ich versuche mein Kind zur Selbstständigkeit zu erziehen.	O	O	O	O	E +
14.	Ich achte sehr darauf, dass mein Kind wichtige Dinge selbst entscheiden kann.	O	O	O	O	E +
15.	Ich zeige meinem Kind, wenn ich stolz auf ihn/sie bin.	O	O	O	O	L +

16.	Um Regeln und Verbote durchzusetzen, müssen Eltern manchmal einfach lauter werden.	O	O	O	O	S +
17.	Zwischen mir und meinem Kind besteht ein echtes Vertrauensverhältnis.	O	O	O	O	L +
18.	Die Regeln werden bei uns von den Eltern aufgestellt – nicht von dem Kind.	O	O	O	O	S +
19.	Über Regeln sollte man mit Kindern prinzipiell nicht diskutieren.	O	O	O	O	S +
20.	Ich habe bestimmte Erwartungen an mein Kind und die müssen auch erfüllt werden.	O	O	O	O	S +
21.	Ich lebe meinem Kind vor, was es heißt, Verantwortung zu übernehmen.	O	O	O	O	E +
22.	Ich übertrage meinem Kind wichtige Aufgaben.	O	O	O	O	E +
23.	Ich bringe meinem Kind bei, dass man für seine Fehler auch einstehen muss.	O	O	O	O	E +
24.	Ich freue mich bei meinem Kind auch über kleine Fortschritte.	O	O	O	O	L +
25.	Ich versuche mein Kind individuell zu fördern.	O	O	O	O	E +
26.	Wenn ein Kind eine wichtige Regel nicht einhält, dann muss das auch Konsequenzen haben.	O	O	O	O	S +
27.	Ich habe ein sehr gutes Verhältnis zu meinem Kind.	O	O	O	O	L +
28.	Kinder sollten schon früh lernen, selbst Verantwortung zu übernehmen.	O	O	O	O	E +
29.	Kinder brauchen ab und zu mal einen Klapps.	O	O	O	O	S +
30.	Ich vermittle meinem Kind Werte wie verantwortliches Handeln und eigenständiges Denken.	O	O	O	O	E +

Appendix C: Consent Form of Participation - German Version

UNIVERSITÄT ERFURT

Kleinkindforschung in Thüringen

Studie:

Studiendurchführende/r:

Einwilligung zur Studienteilnahme

Vor- und Nachname des Kindes: _____

Geburtsdatum des Kindes: _____ _____ _____

Wächst Ihr Kind mehrsprachig auf?

☐ Ja, mit folgenden Sprachen: _____

☐ Nein

Hat Ihr Kind Geschwister?

☐ Ja, und zwar (Geschlecht / Geb.-datum): _____ _____

☐ Nein

Ich bin damit einverstanden, dass mein Kind am Projekt der Universität Erfurt teilnimmt und die Bild- und Tonaufnahmen in **anonymisierter** Form im Rahmen wissenschaftlicher Beiträge bei Forschungs-, Lehr- und Informationsveranstaltungen verwendet werden.

Unterzeichnende/r (Name): _____

Datum: _____ **Unterschrift:** _____

Besucht Ihr Kind einen Kindergarten? ☐ Ja ☐ Nein

Name der Einrichtung: _____

Anschrift (Straße, Nr.): _____

Ich habe den Elternbrief über die Studiendurchführung in Kindertagesstätten zur Kenntnis genommen und bin damit einverstanden, dass mein Kind an den Projekten der Universität Erfurt in der Kindertagesstätte teilnimmt.

Datum: _____ **Unterschrift:** _____

Appendix D: Certificate of Participation - German Version

Kleinkindforschung in Thüringen

UNIVERSITÄT ERFURT

URKUNDE

hat am _____ an unserer Studie teilgenommen und uns bei der Erforschung der kindlichen Entwicklung geholfen.

Vielen Dank dafür!!!

„Kleinkindforschung in Thüringen (KiT)"
Universität Erfurt, Nordhäuser Straße 63, 99089 Erfurt,
Email.: KiT@uni-erfurt.de, Tel.: 0361/737-1155, Fax: 0361/737-1159

Ehrenwörtliche Erklärung

„Ich erkläre hiermit ehrenwörtlich, dass ich die vorliegende Arbeit ohne unzulässige Hilfe Dritter und ohne Benutzung anderer als der angegebenen Hilfsmittel angefertigt habe; die aus fremden Quellen direkt oder indirekt übernommenen Gedanken sind als solche kenntlich gemacht. Bei der Auswahl und Auswertung des Materials sowie bei der Herstellung des Manuskripts habe ich mit Ausnahme meines Dissertationsbetreuers keine Unterstützungsleistungen von anderen Personen erhalten. Darüber hinaus waren keine weiteren Personen an der geistigen Herstellung der vorliegenden Arbeit beteiligt. Insbesondere habe ich nicht die Hilfe einer Promotionsberaterin bzw. eines Promotionsberaters in Anspruch genommen. Dritte haben von mir weder unmittelbar noch mittelbar geldwerte Leistungen für Arbeiten erhalten, die im Zusammenhang mit dem Inhalt der vorgelegten Dissertation stehen. Die Arbeit oder Teile davon wurden bisher weder im Inland noch im Ausland in gleicher oder ähnlicher Form einer anderen Prüfungsbehörde als Dissertation vorgelegt. Ferner erkläre ich, dass ich nicht bereits eine gleichartige Doktorprüfung an einer Hochschule endgültig nicht bestanden habe.“

Ort, Datum	Name	Unterschrift