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The impact of social engagement on attention of infants"

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1. Theoretical background

Just as small and seemingly helpless as a baby arrives in the world, just as fast he or she develops the skills that are necessary to collect information and interact with the people in their environment. Everything that an infant learns until the first birthday is necessary to ensure survival. Within the first year of life, attention processes of infants, which play a crucial role in perceiving the environment and learning from their surroundings, develop fast (Feldman, 2007). After developing the skills to perceive the world they live in, it is important for infants to engage with their environment and social partners. Being able to participate in social interactions with their surroundings not only contributes to their survival, but also facilitates social learning (Höhl & Berenthal, 2021; Schultz et al., 2015).

However, how exactly does social engagement of the infant influence attention? How do the close environment (e.g., siblings and child-care facility attendance) and interactional partners influence social engagement and attention?

1.1 Infants' visual attention processes and early interactions

The visual system of an infant acts as a filter as it is assailed with social environmental information that cannot be processed all at once. This filter enables the infant to direct their attention to only a few important inputs in their environment at once (Hendry et al., 2019). Attention in the first three months of life is provoked by external factors such as novelty or specific stimulus characteristics (Salley et al., 2016). Studies showed that human infants prefer social stimuli and already show a preference for human faces from the moment of birth and can distinguish self-produced human from inanimate action (Hendry et al., 2019; Tomasello et al., 2005; Turati & Simion, 2002). To visually orient attention to the primary caregivers in the surroundings provides the infant with first experiences on social attention (Salley et al., 2016). Usually, the infants' first social interaction experiences occur with the primary caregivers, in most cases the mother (Lavelli & Fogel, 2013). In the first two months interaction mostly depends on responses from the primary caregiver. After two months the infant begins to engage in mutual interaction more actively. The mother usually responds by showing an increase in mirroring the infants behavioral and emotional signs and in that way generating a social interaction with her child (Lavelli & Fogel, 2005; Lavelli & Fogel, 2013). With more experience, the simple information seeking by infants turns into solid social interactions between the infant and a social partner (Hoehl & Berenthal, 2021). How the mother responds to attentional episodes of her child eventually affects the child's behavior and patterns of communication (Lavelli & Fogel, 2013). For example, 3-month-olds with an

attuned mother smile, coo and gaze more at their mothers than infants with less attuned mothers. Infants of depressed mothers respond less to faces and voices in general (Legerstee & Varghese, 2001). Attunement is considered the ability to respond and act upon a child's needs. If the child cries for example, an attuned mother would pay attention and look to calm him or her whereas a less attuned mother would not pay attention or would not understand the needs of her child (*The Power of Attunement*, 2018). Thus, one can recognize the importance of mutual responsiveness and positive feedback within face-to-face interaction on the stabilization and consolidation of early social interactions (Lavelli & Fogel, 2013).

With cortical development between the age of 3 and 8 months, infants are able to process object properties on the basis of internal factors. Due to these changes in the brain, infants are able to increase looking time durations in regard to more interactive and complex stimuli. Furthermore, they also develop the ability for self-regulation of attention with age (Salley et al., 2016).

When adults are interacting with children, they tend to use ostensive cues and gestures (Csibra & Gergely, 2009; Senju & Csibra, 2008). Ostensive cues can be gaze direction, infant-directed speech or getting the child's attention by gesturing (e.g., finger pointing) towards objects (Senju & Csibra, 2008; Wass et al., 2020). As previous studies showed, ostensive cues are very important for infants to develop attentional and perception processes. Infants are highly responsive to ostensive signals and are more likely to gaze and direct their attention to a referred object when preceded by an ostensive signal, for instance pointing at an object (Senju & Csibra, 2008). This already begins at a very young age. Senju and Csibra (2008) conducted an experiment where an actor was looking at objects either with or without ostensive cues. As it turned out, when anticipated by ostensive signals such as gaze or infant-directed speech, 6-months-infants already followed an adult's gaze looking at an object (Senju & Csibra, 2008). However, ostensive cues do not just have an attention-grabbing effect, they also affect infants' learning and facilitate it by directing infants' attention to significant factors in their surroundings (Wass et al., 2020). This makes them very useful tools in helping infants to perceive their environment.

Early sensitivity to ostensive cues has been the topic of many studies. They explain the sensitivity on the basis that human interaction and communication are shaped to transmit knowledge between human beings and serve as indicators for possible trustworthy partners (Csibra & Gergely, 2009; Csibra, 2010). Therefore, adults would use ostensive signals to show their infants important information in their surroundings, and infants would use these

signals to orientate themselves in their environment and generate knowledge (Csibra & Gergely, 2009).

1.2 The development of joint attention and social engagement

In the first 3-4 months the so-called dyadic mother-infant interaction is predominant, and infants seem to prefer social stimuli to object-directed ostensive cues (Striano & Hoehl, 2011; Tomasello et al., 2005). A baby of 3 months still prefers dyadic interaction (Striano, 2004), but already starts exploring his/her surroundings by showing more interest in other objects as well as other people (Feldman, 2007). This means that by 3 months of age, an infant is already able to assert selective attention to non-social objects (Hendry et al., 2019).

The ability for triadic interactions seems to develop between the third and ninth month of an infant's life (Hoehl & Striano, 2013). Therefore, the sensitivity to triadic interactions is developing rather early on. At this crucial milestone in the infants' development, they learn to coordinate their own attention with others and develop the ability to actively take part in triadic exchanges (Hoehl & Striano, 2013). However, triadic interactions between an infant, an interaction-partner and an object do not just occur from one day to the other, but develop gradually throughout the first year of life (Hoehl & Striano, 2013). For instance, the study of Reid and Striano (2005) showed that at the age of 4 months, there are effects on object processing if the infant is part of a triadic interaction with eye gaze or combined head and gaze direction. During the study, adults' gaze to an object facilitated infants' attention to the location. They were looking more at the cued object compared to an uncued object in the study condition (Reid & Striano, 2005).

For instance, Höhl and Striano (2013) conducted a series of studies where 3-, 6- and 9-month-old infants were tested in various social contexts with a social partner. These social contexts included an adult coordinating visual attention between an infant and a toy and a situation where the adult was just looking at the toy and not at the infant but was verbalizing in a positive way. On the one hand, it was shown that the youngest infants of 3 months preferred dyadic interactions (face-to-face without the adult looking at an object while talking and interacting with the infant). On the other hand, the older infants of 6 and 9 months of age paid more attention to the social partner in the triadic context where the adult was also looking at the object while interacting with the infant. These findings indicate that infants start to develop the ability for triadic interactions before 9 months. The ability to engage successfully in triadic interactions can be seen as a developmental success in the first year of life (Hoehl & Striano, 2013).

Triadic interactions and therefore the skill to interact successfully with an object and a social partner in a social context forms the base of joint attention. Joint attention is defined by a triadic context (person-person-object) which involves both an infant's and a partner's mutual attention on a third object or event (Bigelow et al, 2004; Striano et al., 2006). The full capacity of joint attention includes sharing attention, following attention of others and directing attention (Beuker et al., 2013; Carpenter et al., 1998). The ability to respond to joint attention tends to emerge before the ability to initiate joint attention actively (Beuker et al., 2013). A child initiates joint attention when he or she directs the attention of another person towards a shared target, this can be an object or an event (Beuker et al., 2013). At around 6 months of age infants are able to follow the direction of gaze of an adult with their eyes or with a turn of their head (Butterworth & Jarrett, 1991). Around the age of 12-18 months joint attention skills improve a lot as the infant can fixate on an object even though it's not in their visual field and master the skill of following attention (Deak et al., 2000). Learning how to use joint attention and to actively coordinate attention in a triadic situation indicates infants' understanding of their social partners as intentional beings, as they are themselves (Bigelow, 2004).

Previous research (Carpenter et al, 1998) have come to the conclusion that joint attention is quite important for successfully developing skills of social cognition. In particular theory of mind that emerges around the age of 4-5 years, where it is significant to understand the beliefs and thoughts of other people (Carpenter et al, 1998). Therefore, joint attention forms the base of later cultural and communicational learning referring to the outside world. According to previous studies, joint attention plays a major part in language acquisition (Beuker et al., 2013), as it is necessary to master the basis of shared attention before the development of early communication skills can be acquired properly (Tomasello, 1995). Beuker et al. (2013) showed that children in whom directing attention with gaze alternation developed earlier, showed a larger augmentation in vocabulary size between the ages of 10 and 18 months. This could have a quite positive effect on other developmental areas, such as cognition and social skills (Beuker et al., 2013).

Furthermore, studies have shown that joint attention also makes processing objects easier for infants. Höhl et al. (2012) for example found that in a gaze-turning task, infants of 4 months found it easier to process objects with the help of a caregiver's gaze compared to a stranger's gaze. Parise et al. (2008) demonstrated that in a joint attention interaction situation, infants of 5 months show brain responses while processing objects. In this study, the EEG amplitude in the joint attention condition had a higher frequency than in the non-joint

attention condition in the left front-central location of the brain. The results showed that even with 5 months of age, infants are sensitive to elements of joint attention situations (Parise et al., 2008). Striano, Reid and Höhl (2006) investigated the effect of object processing in joint attention situations with infants of 9 months. They found that "the negative component of the infant event-related potential (ERP), a neural correlate indexing attentional processes, was enhanced in amplitude during the processing of objects when infants were engaged in a joint attention interaction compared to a non-joint attention interaction" (Striano et al., 2006, p. 2819).

In a study by Cleveland and Striano (2007) an experimenter presented a novel object in two conditions. In the joint attention condition, the experimenter altered his gaze between the toy and the child while speaking to the infant about the toy, whereas in the "object only"-condition the experimenter altered his gaze between the toy and a spot on the ceiling but never looked at the infant. Results showed that joint attention augmented object processing in the brain in infants of 9 months in the joint attention condition, but not in the "object only"-condition (Cleveland & Striano, 2007).

1.3 Social engagement

As infants approach their first birthday, they also reach some important milestones in their development. In addition to engaging with other people in joint attention through gazing, they also start to point and speak. Actively directing the attention of others by giving, showing, reaching and/or by pointing with and without gaze variation develops around 9-10 months and becomes more common between 12 and 15 months of age (Bates et al., 1975). Before pointing actively, infants develop the ability to follow pointing. Point following even shows a tendency to develop earlier than gaze following (Beuker et al., 2013; Carpenter et al., 1998). By 12 months of age, most infants can successfully locate targets both close and distant (Carpenter et al., 1998). Whereas for gaze following, the ability to locate a specific target when other objects are present in the near environment develops in infants between 12 and 15 months of age (Carpenter et al., 1998).

It is important to mention is that pointing gestures emerge around the same age in infancy in different cultures (Liszkowski et al., 2012). As infants point for different motives, Rohlfing et al. (2022) conducted a study in which it was shown that infants at 12 months already pointed for the imperative motive. Declarative or informative pointing occurred later at 14 months of age. It is also often accompanied by vocal expressions which are related to infants' later linguistic skills in their form and frequency (Murillo & Belinchón, 2012).

There is a direct link between pointing and talking: Iverson and Goldin-Meadow (2005) found that a few months after pointing at certain objects, infants started to talk about them. Various studies have shown that infants' vocalizations and pointing are related to one another. For example, Murillo and Belinchón (2012) have shown that the frequency of pointing gestures in 12-month-old infants in a specific play situation was related to the number of words the infants uttered in a similar situation at the age of 15 months. There were even stronger correlations when pointing was used in combination with vocalizations and gaze. Conversely, fewer pointing gestures indicated a lower level of language learning. Recent findings suggest that children who show less pointing actions at 12 months are also delayed in language processing one year later (Lüke et al., 2017). Moreover, instructing infants to point more during an intervention not only increased the actual pointing behavior expressed with their caregiver, but also in gains in vocabulary (LeBarton et al., 2015). Caregivers responded more to infants pointing combined with vocalizations than to pointing at objects alone (Ger et al., 2018). This might be the case because the combination of pointing, and vocalizing makes caregivers perceive the infants' action as more communicative than pointing alone (Ger et al., 2018).

Therefore, the question arises why pointing and vocalizations are so important. Pointing helps infants to engage actively with their caregivers or social partners, and with the action of pointing at objects of interest, infants learn to initiate joint attention (Moore et al., 2019; Tomasello et al., 2007). Furthermore, infants seem to need pointing to get their caregivers to respond to their actions and receive their full attention (Ger et al., 2018).

Based on previous research, there are already lots of references to the connection of pointing, talking, sharing attention with social partners, and attentional processes. However, it is still not well understood whether infant engagement (checking back with social partners, pointing and vocalizing to share and direct attention) with his or her environment has an impact on attention to objects in a joint attention context. More engagement in the case of this study present means the infant should check back more often with the experimenter and the parent, point at the screen, or should vocalize frequently. Also, it is expected that a higher level of engagement will increase the attention the child is paying to the study situation. Infant engagement will be quantified from behavioral observation, with a focus on infants initiating eye contact with a social partner, as well as displaying pointing gestures and vocalization during a joint attention interaction (i.e., observing images of objects on a computer screen). It is expected that a higher level of engagement with a social partner will lead to enhanced attention to the objects observed together.

1.4 The infant and the social world

1.4.1 Siblings

An aspect that has not been discussed so far is the impact of the social world on the child's social development. The infant's social world refers to the environment and the people that surround the infant, for example parents or caregivers, siblings or persons associated with child-care facilities. Höhl and Berenthal (2021) state that the infant learns about the physical as well as the social world through other people. Infants seek information about unknown objects or situations with other people and with time and more experience, learn to make better predictions about others' actions and intentions (Höhl & Berenthal, 2021). The ultimate goal for the caregivers is to socialize their children which also means helping in developing attentional processes and learning how to socially engage with other people. The fact that social engagement with parents, teachers or other significant adults helps to shape the cognitive development of infants from a very young age is well known. But there is only scarce research about the siblings' role in the process of developing cognitive skills in infants.

However, there are some studies which give some insight into the role of the siblings in social development. In infancy the interaction with the mother is the most important one, and infants between 7 and 25 months of age seem to prefer the social interaction with their mother over the interaction with their siblings (Aldrich et al., 2015). A longitudinal study of infants from 6-18 months of age (Bakeman & Adamson, 1984) concluded with similar results, that joint engagement occurred more frequently with the mother than with peers. Bakeman and Adamson (1984) also explained the effect that mothers might support joint attention and the attention shifting of their infants on a mutual object more than peers. Lamb (1978) as well found that infants interact more with their parents than with their siblings if given the choice, although he concluded that the interaction between the older siblings and the infant is rather special. While playing, the infants were watching and monitoring the actions of their siblings with great interest and were more likely than older children to play with an abandoned toy directly after the sibling stopped using it and, in that way, imitating the other's behavior. On the other hand, the older siblings were rather playing on their own and when interacting with their younger infant siblings, were more likely to vocalize or proffer toys. These findings suggest that siblings play an important role in facilitating knowledge over the inanimate surroundings (Lamb, 1978). Furthermore, imitation is a very powerful tool for learning during infancy (Barr & Hayne, 2003). Barr and Hayne (2003) conducted a study to investigate how siblings would influence the learning process through imitation. The results speak for themselves: For example, they found that infants with older siblings imitated other children

more often than infants without older siblings. They even modelled approximately 50% of the behaviors they learned in the study context with the sibling on actions performed by another child. Additionally, they were able to imitate actions without clear instructions compared to infants without siblings. In the context of the study parents reported that infants with older siblings would imitate more "rough-and-tumble actions" (e.g., boxing, chasing, playful fighting) and more pretend play actions than infants without siblings (Barr & Hayne, 2003; Lamb, 1978). Pretend play would be for example siblings playing 'shopping' with baskets and food, crawling around the floor and pretending to be animals or using objects as though they were something different. Imitation of joint pretend play has been argued to promote developing skills like problem solving, creativity, negotiation, and planning (Barr & Hayne, 2003).

Barton and Tomasello (1991) observed that in mother-infant-sibling triads (playing sessions) conversations were three times longer than in dyadic conversations with just the mother and one child present. They concluded that infants experienced a richer learning environment, especially for language learning, when the older sibling was present (Barton & Tomasello, 1991).

In light of previous research, it is assumed that with the impact of a sibling the infant has more exposure to actions of social engagement and therefore would engage more actively with an unknown social partner during the present study. In this study it will be investigated whether that is the case.

1.4.2 Child-care facilities

In Austria there is a high standard of childcare for infants and children. Ranging from preschool to after-school daycare, childminders, kindergarten or crèches, there are various possibilities to put a child in the care of trained childminders while the parents go to work. Public childcare in Austria includes supervised playtime all day long with meals and learning in mixed groups. Kindergarten normally includes children from the age of 3 to 6 whereas crèches or nurseries are for infants under 3 years of age (Walker, 2022). As of September 1st, 2021, 18.840 infants under the age of 3 years were cared for in crèches, 153 in kindergartens, 22.472 infants in daycare facilities ("Kindertagesheimgruppen") and 3.479 in child-care facilities of kids of various ages (Statistik Austria, 2021). In the year of 2021 29.1% of infants from 0 to 2 years of age were enrolled in child-care facilities (Statistik Austria, 2021). As there is quite a huge number of infants spending time away from home and their parents, it is important to investigate what impact the stay at a child-care facility has on the child.

There are various, mostly positive, findings on the impact of child-care facilities and the development of children there. In general, the impact on the development depends a lot on the quality of the child-care facilities (Peisner-Feinberg, 2007). High-quality child-care includes a variety of factors such as responsive and stimulating care and a good teacher-child relationship, adequate classroom practices (daily organization, activities), a proper group size and the qualification of the childminders (Peisner-Feinberg, 2007). Positive outcomes of high-quality child-care on a child's development can be better cognitive and language development, better relationships with future teachers and fewer problems in behavior (Bennett, 2021). Moreover, the opportunity for infants and children to interact with peers their own age helps them to learn about social interactions very soon. They can learn how to handle social offers, how to get in contact with peers and how to resolve conflicts in a safe environment of a group-setting supervised by qualified childminders. It is argued that peers can act as 'surrogate siblings' and enhance imitation and other aspects of cognitive processes (Barr & Hayne, 2003). The younger children in child-care can benefit from learning from the older children in the child-care facility and develop their skills (Barr & Hayne, 2003). Even children with behavioral problems can benefit from a non-parental care environment to develop better social skills, even though it can at first be challenging at the child-care facility (Bennett, 2021).

If the child-care facility quality is very poor and the child spends many hours there during the week, especially at a younger age, it can endanger the infant-mother attachment (Bennett, 2021). Additionally, if the mother is in general insensitive to her child's needs, a child-care facility of poor quality can even pose more challenges for the infant-mother attachment. Therefore, a great amount of time spent in child-care and poor parent-child relationship can lead to behavioral problems (Bennett, 2021).

In terms of cognitive development children of 15, 24, and 36 months of age, who were cared for exclusively by their mother, scored similarly on cognitive and language gains compared to children the same age in child-care facilities (Peth-Pierce, 1998). Differences emerged when a high- and low-quality child-care facility were compared to exclusively maternal care. Compared to exclusive maternal care, children in high-quality facilities even had an advantage in cognitive and language development over children in low-quality facilities, in whom a disadvantage could be observed (Peth-Pierce, 1998).

However, the attendance of infants in a crèche or kindergarten seems to have mostly positive impacts, especially on cognitive and language development.

Given these findings it is assumed that with attendance in a child-care facility, the infant has more exposure to actions of social engagement with teachers and peers, and therefore would engage more actively in the study session (checking back more with the experimenter and parent, vocalizing and pointing more frequently).

1.5 Social engagement and the face mask

The coronavirus (Covid-19) pandemic which began in 2020 continues to take up an immense part in all sections of life and the constant presence of face masks has become a crucial aspect in everyday life. Even though mask use continues to be a heatedly debated topic, masks serve to inhibit the wearer from transmitting respiratory diseases, such as the coronavirus. However, the mask covers a great part of the human face, including the mouth, and prevents other people from using the face as an indicator for non-verbal communication or inhibits verbal communication. This can lead to negative effects in social interaction as the face mask impedes other human beings from gaining important information (Carbon, 2020).

Especially infants use faces of others to acquire communicative and social skills with the help of gaze direction, facial expressions and eye and lip movements. With the face mask covering the nose and mouth, the possibilities to use facial cues are scarce. Following gaze directions is quite important to help the infant engage in joint attention which enhances learning and social interaction abilities. Infants' attention to a social partner's mouth also helps with the acquisition of language and speech and therefore social skills (Pons et al., 2019).

When speaking with an infant, Pons et al. (2019) observed that 4-month-olds attend mostly to the eyes of the social partner and that at 8-10 months the attention shifts more to the social partner's mouth. Later, at 12 months infants attend equally to the eyes and mouth. The authors suggest that the shift from eyes to mouth happens because by 8-10 months the infant starts to take more interest in speech and starts babbling. The study showed that infants pay even more attention to a speaker's mouth when the talker is speaking in an unfamiliar language (Pons et al., 2019).

Studies during the Covid-19 pandemic have indeed shown that wearing face masks, which are covering a big part of one's face, can lead to several problems. For example, identifying persons, understanding acoustic messages and emotional recognition seem to be problematic (Carbon, 2020, 2021; Freud et al., 2020).

At times of a pandemic, it is challenging to conduct research studies in general and even more so with children or even infants. Therefore, there is little research on how face

masks influence children's development and social behavior. However, few were able to investigate the influence of face masks on both adults and children. Carbon & Serrano (2021) for example conducted a study in a school-university project with children of 9 to 10 years about wearing face masks and the impact of them on emotional reading. Reading emotions like disgust, fear and sadness proved to be quite problematic for children, whereas there were only mild effects on the emotion of happiness. Curiously, the emotion of anger and neutral faces could be better perceived when faces were masked. Results of another study by Carbon (2020) were compatible with the study before. Not only had the participants problems with recognizing facial emotions, but also confused several emotions (disgust confused with anger, happiness confused with neutral facial expressions, anger confused with disgust, neutral expressions, and sadness) (Carbon, 2020). In this study, adults were assessed for recognizing emotions behind masked faces and results were comparable to the ones with the children: The face mask was impairing adults' ability to recognize emotion (Carbon, 2020).

Regarding attentional processes, according to a study of Dalmaso et al. (2021), the face mask does not impair gaze cueing of attention which presents the attentional response to gaze signals of other people. In a study with infants between 8 and 10 months old, adults were cueing objects by gaze while wearing masks and compared to adults cueing objects by gaze without masks. Results showed that the fact that the adults were wearing face masks did not have a negative impact on infants' object encoding (Thiele et al., 2021). Therefore, some processes like gaze cueing seem to be unimpaired.

As there is little research on how exactly face masks influence social engagement of infants, this study might give some insight on this topic even though the hypotheses were just tested exploratorily.

2. Research questions and hypotheses

Summarizing previous research, it can be assumed that infants' attention processes are shaped by social engagement with a social partner in their environment. The study intends to underpin existing results from prior research focusing on the impact of joint attention, ostensive cues and social engagement on attention of infants at the ages of 11-13 months. Furthermore, it intends to examine how social experiences of the infant influence the amount of social engagement and attention. Social experiences are assessed in this study based on infants having siblings or attending childcare. As part of the data collection started before the Covid-19 pandemic and was continued and finalized during the pandemic, the opportunity arose to compare two groups of infants, one group tested with experimenters wearing face

masks and one without. As there is little research on how face masks affect people in general, there is even less research with infants. To gain a little more insight into this specific subject, an exploratory hypothesis was included in order to investigate whether infants' social engagement changes if experimenters wear a face mask during the study or not.

To address these questions, behavioral micro-coding of infants' gaze and social behavior with the software Mangold INTERACT (Mangold, 2020) was carried out to assess the trials for infants' gaze, pointing and vocalization. Social engagement in this study is defined as the frequency of the infant pointing towards the screen, vocalizing or seeking attention of the parent or experimenter regarding the pictures they watch together. Looking time duration was measured in milliseconds with a focus on the infant looking at the images on the screen. Demographic data were collected through a parental self-report questionnaire which the parent who accompanied the infant to the study had to fill out (see Appendix A). Considering previous findings and research, the following research questions will be investigated.

2.1 Hypotheses

1. Does engagement influence infants' attention?

Hypothesis 1.1: Social engagement changes over the course of the task (following interaction with the experimenter).

This hypothesis will be tested by comparing engagement (composite score of infants looking at parent and experimenter, pointing at screen and vocalizing) across pre-, interaction- and post-phase conditions. It is expected that engagement will be higher in the interaction vs. pre-phase, and higher in the post-phase vs. pre-phase because the infant should engage more with the experimenter in the interaction phase and generally engage more in the post-phase.

Hypothesis 1.2: Social engagement predicts attention (quantified by looking time to the images) during the task.

To test this hypothesis, we will examine if the frequency of social engagement across the task predicts looking time to the images across the task. It can be assumed that social engagement indeed predicts attention during the task.

2. Do social experiences in daily life predict the frequency of social engagement and looking time during the task?

Hypothesis 2.1: Having siblings predicts the frequency of social engagement during the task.

Hypothesis 2.2: Child-care facility attendance predicts the frequency of social engagement during the task.

Hypothesis 2.3: Having siblings predicts the looking times during the task.

Hypothesis 2.4: Child-care facility attendance predicts the looking times during the task.

To test these hypotheses, two groups will be formed for each independent variable (having siblings/not having siblings; attends child-care/does not attend child-care). It will be tested if engagement and looking times of infants with siblings differs from infants without siblings. The same will be tested for child-care facility attendance compared to no child-care facility attendance.

2.2 Exploratory hypotheses

As of the current pandemic situation, it is interesting to investigate if the infant would engage communicatively more with the social partner (=experimenter) in the pre- or post-pandemic group. First, a comparison will be drawn between the two groups pertaining to which behaviors are affected by the experimenter wearing a mask. After comparing each of the behaviors, social engagement will be tested with a composite score. It is expected that due to the isolation experience during the lockdown, infants in the post-pandemic group should engage less with the experimenter than infants in the pre-pandemic group. Furthermore, as the post-pandemic group is interacting with an experimenter wearing a face mask, it would be expected that the infant is checking back more with the parent instead of the experimenter when looking at the images.

Considering the previous points, the following research questions and exploratory hypotheses will be investigated:

3. Does the social partner wearing a face mask influence the engagement between them and an infant?

Hypothesis 3.1: Infants show less engagement with the experimenter in the post-pandemic group than in the pre-pandemic group.

Hypothesis 3.2: Infants show more engagement with the parent than with the experimenter in the interaction phase in the post-pandemic group.

To test these hypotheses, social engagement of infants in the pre-pandemic group will be compared to social engagement of infants in the post-pandemic group. Furthermore, social engagement of the infants in both groups with the experimenter and the parent present during the study session will be compared.

3. Methods

The study was conducted at the Department of Developmental and Educational Psychology at the Research Unit *Vienna Children Studies* (Wiener Kinderstudien) at the Faculty of Psychology at the University of Vienna. It was approved by the Ethics Committee of the University of Vienna (Ref. 00382). Supervision was provided by Univ.-Prof. Dr. Stefanie Höhl and Anna Bánki, MSc. In the following, the methods and the procedure of the study are presented and described.

3.1 Recruitment

The recruitment was carried out by the Research Unit Developmental Psychology at the University of Vienna. It was organized via the institute's own voluntary database. Parents signed up to the database after being recruited at the Wiener Allgemeine Krankenhaus (hospital; Department of Obstetrics and Gynecology of the Vienna General Hospital) and in various parent groups (e.g., baby yoga, parent-child music groups). They were contacted by phone or email and informed about the study, the general procedure, and conditions for participation. They were informed that the study was associated with no risk for the infant and that the assessment could be stopped at any time. Infants with prematurity or neurological disorders such as epilepsy were excluded from the recruitment process. For participation and recording of personal data, parents were instructed to provide written informed consent prior to the study. After participation, parents received a travel compensation of 6 euros, and the infants received a certificate and a toy.

3.2 Participants

The total sample size consisted of n = 51 infants. All infants were born full-term, had a typical development and no known neurological disorders.

3.3 Research design

In this between-subjects study, a pre-post design with an interaction-phase in-between was applied to examine the effect of social engagement on infants' attention to a visual scene. The procedure was preceded by a short warm-up phase of approximately 5 minutes.

3.4 Demographic data

The parents were asked to fill out an online questionnaire at home to gather demographic data (see Appendix A). The infants' age ranged from 11 to 13 months (*M* =

11.9, *SD* = 0.53). The youngest child was 11 months and the oldest child 13 months old. Of the 51 participants, 28 were males (54.9%) and 23 females (45.1%). The primary caregiver (the person who stayed at home with the infant) was the mother for all 51 children. The age of the mothers ranged from 24 to 41 years (*M* = 33.3, *SD* = 4.05). In terms of siblings, 36 infants didn't have siblings (70.6%), 7 had one sibling (13.7%), 6 had two siblings (11.8%) and 2 infants had 3 siblings (3.9%). For the study, the infants with siblings were summed up to one group of 'having siblings' (*n* = 15). Across the sample, only a small proportion of infants attended a child-care facility in Austria, 7.8%, with most infants being cared for at home (92.2%). Seven (13.5%) infants were tested before the Covid-19 restrictions came into place (= no face mask) and 44 (84.6%) infants were already tested with Covid-19 restrictions and with an experimenter wearing a face mask during the whole session.

Table 1

Demographic information about the participants

Sample

n = 51

	n	*%*
Gender		
Female	23	45.1%
Male	28	54.9%
Care Taking		
Kindergarten	4	7.8%
At Home	47	92.2%
Siblings		
Yes	15	29.4%
No	36	70.6%

	n	*M*	*SD*	*Min*	*Max*
Age of infants (months)	51	11.9	0.53	11.0	13.0
Age of mother (years)	51	33.3	4.05	24	41

	n	*%*
Covid-19		
Pre-pandemic group	7	13.5%
Post-pandemic group	44	84.6%

Note. Table 1 shows the demographic information about the sample used to test the hypotheses in this study.

3.5 Study procedure and stimuli

The infants came to the testing room facilities of the Vienna Children Studies at University of Vienna accompanied by their caregiver for an experimental session of around 60 minutes. Before the actual testing session started, the parents were asked to fill out a questionnaire (see Appendix A) to gather demographic data if they hadn't filled it out beforehand online at home and were informed about the study and provided written informed consent for participation.

Then an EEG (electroencephalography) cap was put on the infant's head to measure brain activity. Neural data was collected for subsequent analyses but is not in the scope of this master thesis.

The experimental session began with a warm-up phase between the experimenter and the infant. During this phase, the infant got to know the experimenter by playing with her for around 8 minutes with 5 standardized toys (one minute per toy, measured with a stopwatch). The experimenter introduced the toys one by one to the infant and showed interesting features to the infant on each toy. Then turn-taking was facilitated to play with the toys together (e.g., rolling a ball, driving a toy car towards the infant, accompanied by infant-directed speech). When playing with one toy was completed, the experimenter moved it out of the infant's sight and started to introduce a new toy. Afterwards, the experimenter and the infant looked at a specific book ('Sachen suchen') together. There the experimenter was pointing out various objects and context elements to the infant and getting his or her attention. The experimenter showed 5 elements of objects and backgrounds on five distinct pages in the book and accompanied pointing with a verbal comment. There were 5 standardized verbal comments used: 'Oh! Schau mal (hier)! Guck mal! Was ist das? Siehst du das?' The whole warm-up phase was recorded on video.

Before starting the experimental session, the experimenter instructed the parent to sit on a chair in front of a computer screen with the infant on his or her lap facing the screen. A camera was located right beside the computer screen on a tripod to record the whole session. The parent was told not to intervene vocally nor point at the screen to catch the child's attention. The parent was also told that they could take a break anytime they wanted if the child started to get fussy or to put a snack or a toy in their hand.

During the pre- and post-phases, the infant sat on their caregiver's lap and watched flickering images depicting natural objects (e.g., animals, everyday objects) on the computer screen. Every image consisted of a natural object and a background. The experimenter left the room during the pre- and post-phases. The pre-phase consisted of 16 images. Each image was

displayed for 3 seconds on the screen. The post-phase consisted of 32 images, displayed for 3 seconds each. During the trials, no interaction took place. Between the pre- and post-phase, the session included an interaction-phase. The interaction-phase consisted of 32 trials, each one displayed for 4 seconds. In each phase, the same 8 images were shown: twice in both the pre- and post-phases, four times during the interaction. In the post-phase, 8 new images were shown twice additionally. The order of the images was randomized across phases and participants. Each image was preceded by an attention getter of a variable duration of 0.5-1.0 s (a white circle in front of a black background) accompanied by an infant-friendly sound (five different sounds in a randomized order) to draw the infant's attention to the screen.

At the start of the interaction phase, the experimenter entered the room and sat beside the parent and the child on a chair. When the images appeared on the screen, the experimenter pointed her index finger to the background, or the object shown on the image and said one of a few standardized sentences to grab the infant's attention. The infants were divided into two groups (object/background). For the children of one group, the experimenter always pointed out the object, and the other group the background to assess if visual cortical processing can be shaped by attention guidance in a standardized way. The idea about pointing to different parts of an image in this study is about the culture-specific visual attention in infants to an object or a background. However, culture-specific visual attention is not the topic of this master thesis and will therefore not be discussed further.

In all phases, both object and background of each visual scene were flickered with different driving frequencies (5.66 and 8.5 Hz) to track infant's selective attention to object and background. This approach is called frequency-tagging: Dependent on which element the participant attends to, a stronger response (steady-state visually evoked potential or SSVEP) can be seen on the EEG for the relevant driving frequency, allowing to disentangle neural responses for object and background (Köster et al., 2017). However, since neural data was not included in the current analysis, the EEG paradigm will not be further discussed.

There were only three experimenters involved in the study who were trained together to standardize the duration of their pointing (index finger moving to the screen) and verbal comment. They were trained to point and comment in the first second of the trial, keep the verbal comment short and point until the image faded away. Furthermore, the experimenters avoided eye contact with the infant during pointing and looked at the screen to drive attention to the stimuli. Between the stimuli images, experimenters sometimes looked at the infant or helped to calm him or her down when it was necessary.

Between trials, as well as during breaks, in case the infant's attention dropped, a child-friendly animation (a black spiral turning in front of a white background accompanied with music) was presented. At any time, if needed, a short break was introduced. At the end of the trial, the caregivers were debriefed on the purpose of the experiment and infants received a certificate and a toy. Participants were compensated for the travel costs on a fixed rate.

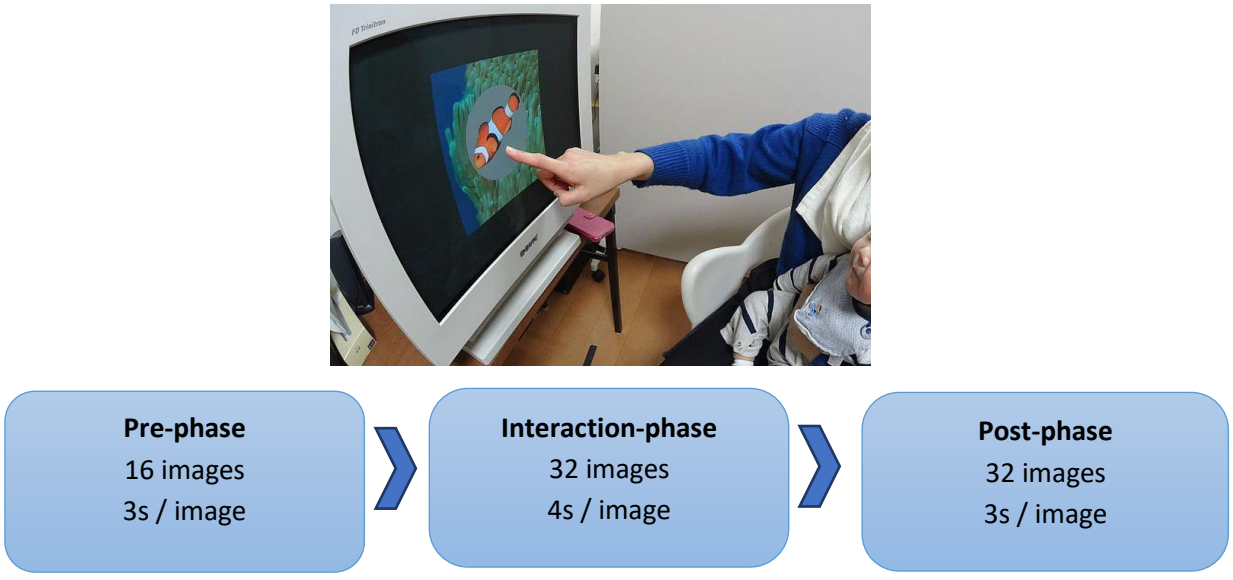
Figure 1

Warm-up phase

Note. Figure 1 shows one page of the book 'Sachen suchen' (left) and the five standardized toys.

Figure 2

Study design



Note. Figure 2 shows the study design. Photograph adapted from Bánki et al. (2019).

Figure 3

Image examples

a) Animals **b) Objects**

Note. Figure 3 shows two image examples which were shown to the infants. Photographs adapted from Bánki et al. (2019).

3.6 Data analysis

3.6.1 Attentional data coding

The experimental situation was recorded by a video camera on a tripod beside the infant who was looking at the images. The video recording was performed at 60 frames per second. The level of attention was measured by looking time at the images which were coded with the onset and offset of gaze to the images. Behavioral micro-coding of video data and looking time duration was performed with Interact (Mangold, 2020). Interrater reliability for the video coding was calculated based on 13 videos double coded by two independent coders. The observer agreement between two independent coders was high (Cohens $\kappa = 0.83$).

Full trials (Figure 4) were the ones where infants were looking at the screen from the onset of the picture (=image flickering started) until the offset of the image (=image vanished).

Missed and look-away trials were the ones where infants either failed to look at the screen completely or were looking at the image from the beginning but looked away before the offset of the image. There was also the case when infants did not look from trial onset but only shortly after and then looked until trial offset. If the infant was looking away earlier than the offset picture, only the time the infant was looking at the picture was considered for measuring attention (see Figure 5).

During the interaction-phase, the attention of the infant was considered from the experimenter pointing at the picture until the offset of the picture. Missed or look-away trials were the ones where the infant was looking away shortly after pointing and looked until the offset of the image, or the infant was looking until the start and looked away before the offset of the picture.

Figure 4

Coding timeline of a full trial during pre- and post-phases

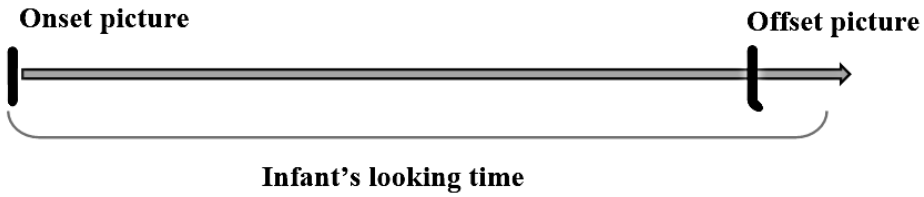
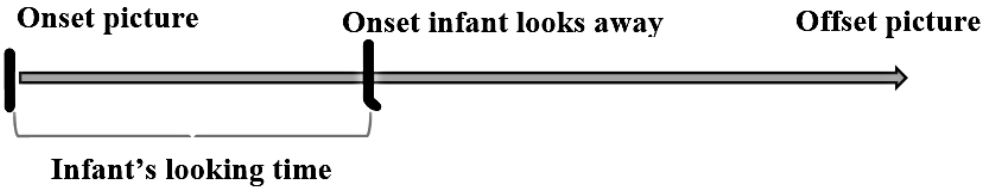


Figure 5

Coding timeline of a short trial (missed/looked away) during pre- and post-phases



3.6.2 Behavioral data coding

The frequency of social engagement of the infant was measured by the frequency at which the infant showed four specific behaviors while looking at the screen or between stimuli images. The frequency of social engagement was only coded by one coder, although it is still a limitation and reliability coding would have been ideal also for coding pointing, vocalizing, and checking back with caregiver and experimenter. But the behaviors were clear from the videos.

The four types of behaviors considered for this study were the following:

- Infant looks at parent before, during or after looking at the picture ("P")
- Infant looks at the experimenter before, during or after looking at the picture ("E")
- Infant points at the picture while looking at it ("IP")
- Infant vocalizes while looking at the picture ("IV")

The behaviors were coded separately for each trial, mostly while the images were displayed. The behaviors "looking at parent" and "looking at experimenter" were coded also in the short breaks between the pictures, e.g. when the child is still checking back with the experimenter or parent while one image fades away and the other starts or when the child is looking at the experimenter/parent before the picture appears on the screen and then starts shifting his/her gaze to the picture instead of the social partner. If the infant was showing more than one specific behavior during one trial, all were considered (e.g., "IP, IV, E"). If the

infant was looking at the parent or the experimenter repeatedly during one trial, it was just considered once for the composite score.

As the trials were very short (3 and 4 seconds), there was not enough time for the infants to show a specific behavior repeatedly during one trial. Even though the argument can be made for both approaches to quantify the frequency of behaviors, in this study analyses were made by counting the same behavior several times in one trial as one, as it is related to the same focus of attention per trial, even if it appears more than once.

"Checking behavior" in general was calculating both looking at the parent or experimenter without looking back to the screen and altering the gaze from the parent or experimenter to the screen and back to the adults or vice versa. For example, the experimenter says one of the few standardized sentences and pointed to the screen and the infant looked at the experimenter and then followed the finger to the screen. Whether the child was looking at the screen and not elsewhere in the room was discernible in the recordings.

"Pointing behavior" was considered when the infant pointed of his or her own accord to the screen and was looking at it or looked at the adults while pointing at the screen. A pointing gesture was identified when the infant reached with their hand slightly towards the screen and the images and pointed with their index finger. It was not important if the index finger was outstretched completely or just so that the gesture was clear. It could also be accompanied by vocalizations.

"Vocalizing behavior" was considered when the infant was expressing noises or babbled while looking at the picture. The infants were not old enough to speak clear words yet but the intention to somehow comment on the image on the screen was made clear. It could also be accompanied by pointing behavior or checking behavior.

Figure 6

Coding timeline of a full look trial during the interaction phase while pointing and vocalizing

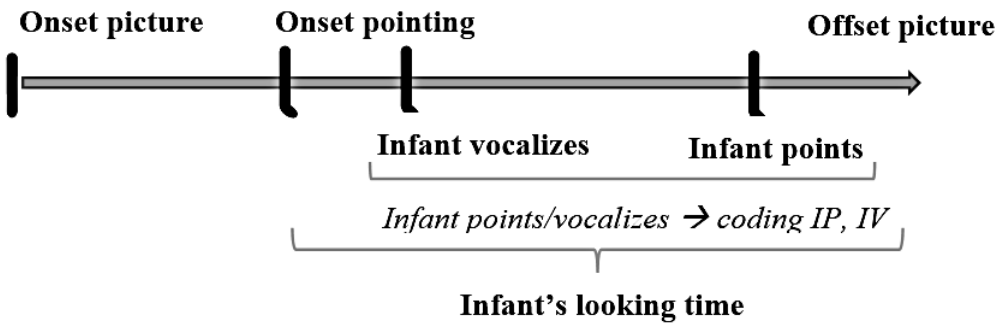
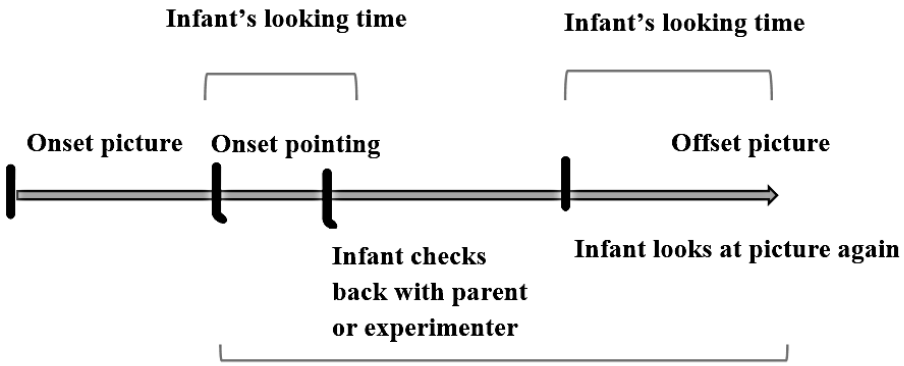


Figure 7

Coding timeline of a short trial during the interaction phase while checking back with parent and experimenter



3.7 Statistical analysis

Statistical analysis was carried out with *IBM SPSS* and *Microsoft Excel.* Assumptions of statistical procedures were tested in advance. Normal distribution was tested with the Shapiro-Wilk test and a graphical analysis, using Q-Q-plots. Variance homogeneity was tested by Levene's test.

3.7.1 Social engagement scores

Social engagement was quantified by calculating composite scores of social engagement behavior during the specific phases. Social engagement behaviors were defined as checking back with parents (P) and experimenters (E), pointing (IP) and vocalizing (IV). A composite score of all behaviors per phase was created. When an infant showed a certain behavior twice in one trial, it was calculated as one.

3.7.2 Looking behavior

Looking behavior was explored with the actual looking times of the infants at the images. The looking time was calculated in milliseconds (ms). Full trials and look-away trials were included in the testing. The looking time of the trials in one phase was summed up to ascertain the attention levels. Missing trials where the infant was looking away were completely excluded.

4. Results

Before the investigation of the hypotheses, a descriptive analysis of the separate behaviors checking back with parent, checking back with experimenter, pointing and vocalizing was calculated throughout the phases in order to compare the behaviors.

The data in Table 2 shows that there are clear differences in the behaviors throughout the phases. The least engagement took place in the pre-phase. In the post-phase there was more engagement in the form of vocalization and pointing compared to the pre-phase. Most of the social engagement took place in the interaction-phase. Pointing was the most used form of engagement by the infant with his or her environment throughout the task, followed by vocalization.

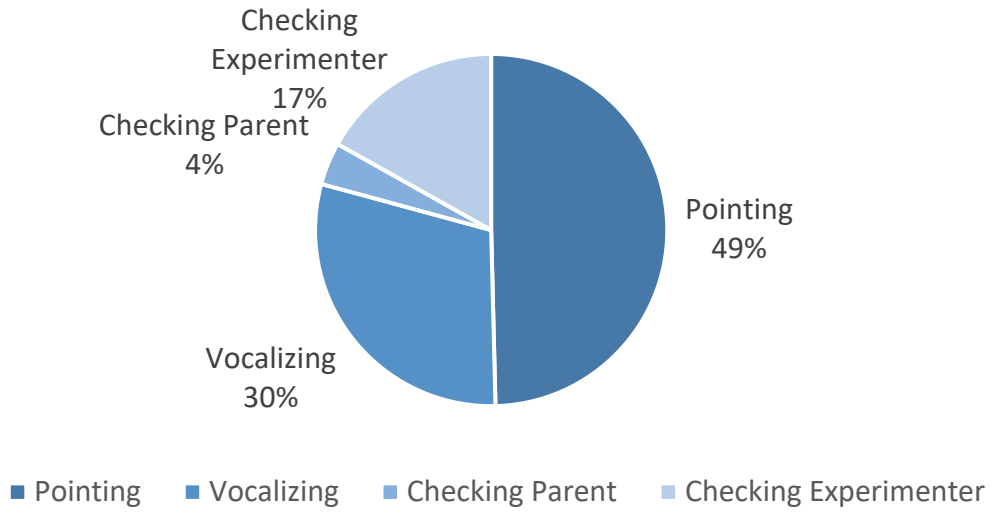
Table 2

Descriptive data of the separate behaviors during the phases

Sample	n = 51		
	M	*SD*	*Sum*
Pre-phase			
Vocalizations	1.12	2.11	57
Pointing	2.63	3.72	134
Looking at parent	.31	1.18	16
Total behavior	4.06	5.41	207
Interaction-phase			
Vocalizations	4.16	4.56	212
Pointing	6.10	6.52	311
Looking at parent	.37	.774	19
Looking at experimenter	4.24	3.06	216
Total behavior	14.86	10.08	758
Post-phase			
Vocalizations	2.16	2.22	110
Pointing	3.73	4.04	190
Looking at parent	.29	.58	15
Total behavior	6.18	5.17	315

Figure 8

Frequencies of behaviors in total throughout the whole task



4.1 Engagement influences attention

4.1.1 Social engagement changes over the course of the task

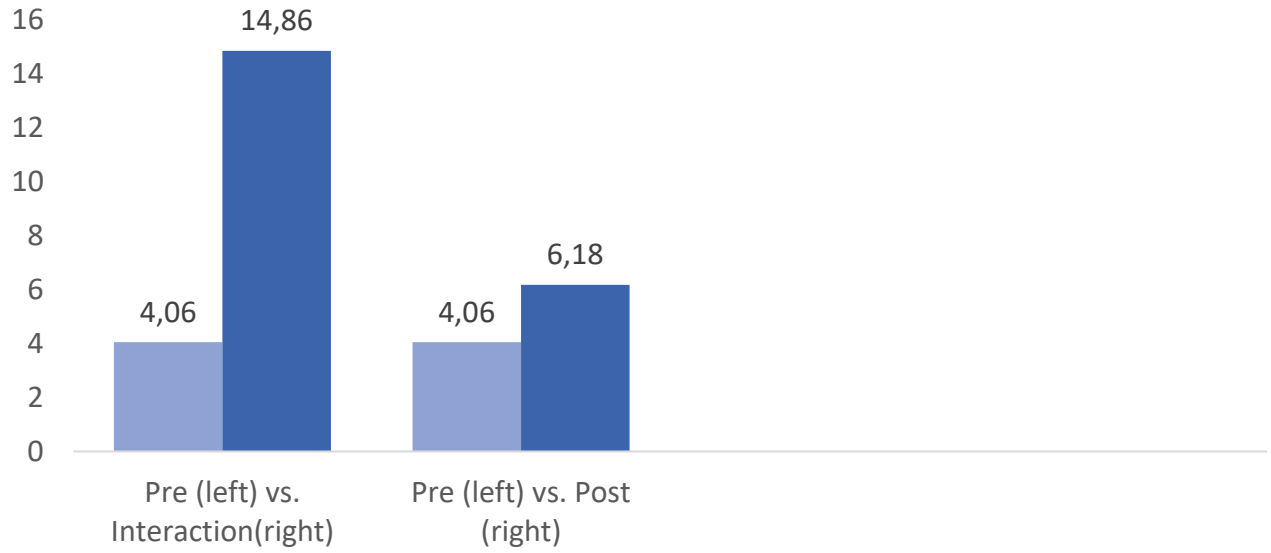
Social engagement during the task was quantified by calculating a composite score of social engagement behavior in the specific phases. To investigate if social engagement changed over the course of the task, a repeated measures ANOVA with within subjects' condition was performed. The assumption of normal distribution as tested by Shapiro-Wilk test, p <.05 and visual inspection with Q-Q-Plots, was not fulfilled. However, in accordance with the *central limit theorem* stating that sample sizes above 30 are large enough to assume normal distribution, and due to the robustness of ANOVA (Field, 2009), the planned analysis was carried out. Mauchly's test indicated that the assumption of sphericity had been violated, $\chi 2(2) = 11.71$, p <.05.

Therefore, Huynh-Feldt correction was used for the interpretation of the results. The ANOVA revealed that there was a significant effect of social engagement throughout the phases $F(2, 49) = 52.88$, p <.001, $\eta p2 = 0.51$.

Pairwise comparisons revealed that social engagement during the interaction-phase differed significantly from social engagement during the pre-phase (p <.01) and social engagement in the post-phase differed significantly from social engagement during the pre-phase (p <.05).

Figure 9

Mean scores of social engagements pre- vs. interaction-phase and pre- vs. post-phase



Note. The figure shows the mean scores of the phases compared in hypothesis 1.1.

4.1.2 Social engagement predicts attention

To investigate if social engagement predicts attention, a correlation matrix was performed at the beginning of the task, followed by a simple linear regression. The composite score of social engagement throughout all phases and the score of total looking time duration throughout the whole task were correlated, as were social engagement and looking time of each phase separately. Looking time duration and social engagement during the pre-phase were moderately negatively correlated, $r(49) = -.43$, $p < .01$. Looking time duration and social engagement during the interaction-phase and the post-phase were not correlated. Looking time duration and social engagement across the whole task were moderately negatively correlated, $r(49) = -.38$, $p = .006$.

Two simple linear regressions were calculated to predict attention based on social engagement for the variables which showed a significant correlation. The assumption of normal distribution as tested with the Shapiro-Wilk test, $p < .05$ and visual inspection with Q-Q-Plots, was met. First, a linear regression was calculated using looking time duration during the whole task as the dependent and social engagement during the whole task as the independent variable. There was a significant regression equation found ($F(1,49) = 8.16$, $p < .01$, with an R^2 of .14. The regression coefficient of the variable “social engagement” was

significant ($t(49) = -2.86$; $p < .01$). Therefore, social engagement throughout the whole task is a significant predictor for looking time duration throughout the whole task.

Second, a linear regression for looking time duration during the pre-phase as the dependent and social engagement during the pre-phase as the independent variable was performed. The assumption of normal distribution as tested with the Shapiro-Wilk test, $p < .05$ and visual inspection with Q-Q-Plots, was not fulfilled. However, in accordance with the *central limit theorem* (Field, 2009), the planned analysis was carried out.

There was a significant regression equation found ($F(1,49) = 11.30$, $p < .01$), with an R^2 of .19. The regression coefficient of the variable "social engagement" was significant ($t(49) = -3.36$; $p < .01$). Therefore, social engagement during the pre-phase is a significant predictor for looking time duration in the pre-phase.

Table 3

Results of the linear regression (H1.2)

Independent Variable	*F*	*df1*	*df2*	*T*	*p*
Behavior whole task	8.156	1	49	-2.856	.006
Behavior pre-phase	11.304	1	49	-3.362	.002

Figure 10

Scatterplot of social engagement and looking time throughout the whole task

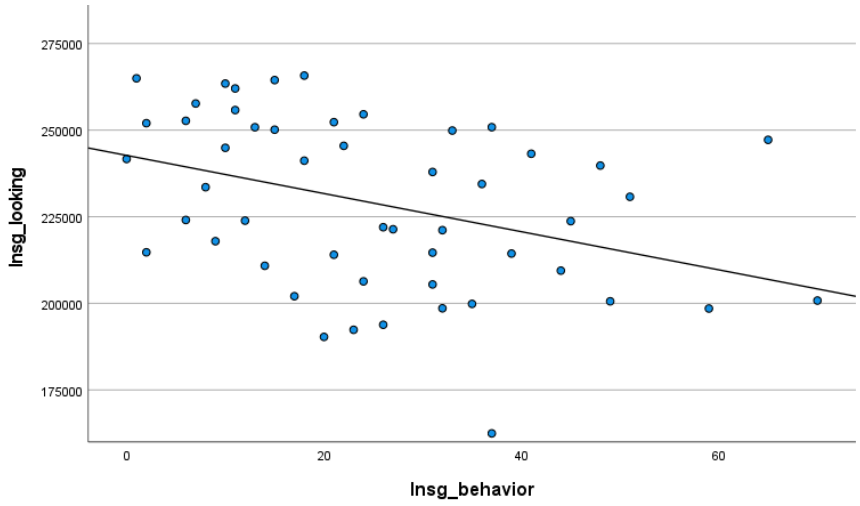
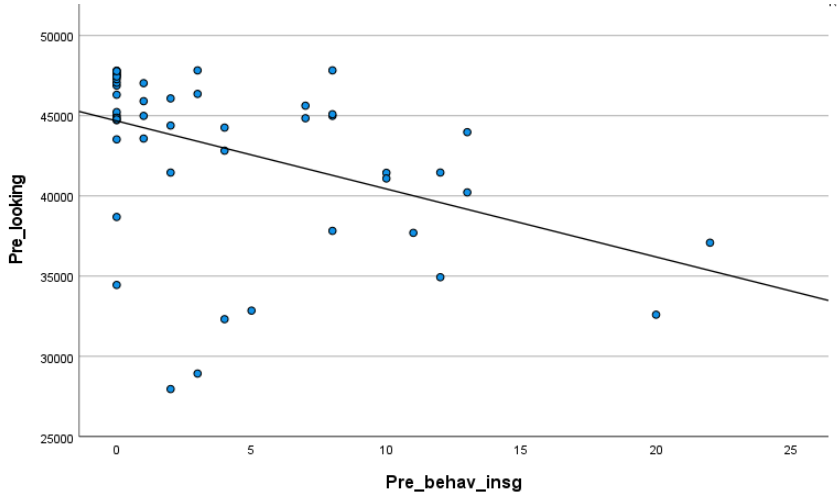


Figure 11

Scatterplot of social engagement and looking time during the pre-phase



4.2 Social experiences influence social engagement and looking time duration

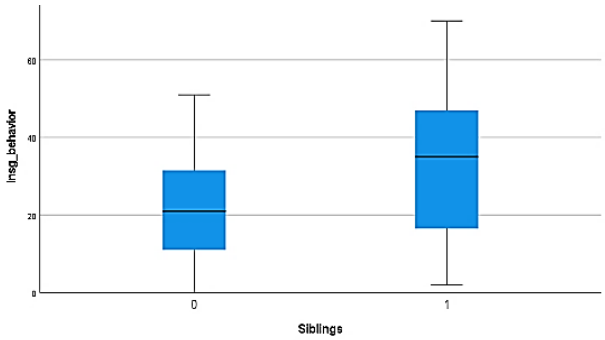
4.2.1 Siblings and child-care facility influence social engagement

For the comparison of infants' social engagement with the groups "siblings"/"no siblings", an independent t-test was conducted. According to Shapiro-Wilk test, normal distribution was not given, p <.05. However, in accordance with the *central limit theorem*, (Field, 2009), the analysis was carried out. The required assumption of variance homogeneity was tested with Levene's test. Heterogeneity of variance was present due to a significant Levene's test, $F(1,49) = 5.40$, p =.024. Therefore, an independent t-test with Welch's correction was used.

On average, social engagement of infants with siblings (M = 33.20; SD = 21.28) significantly differ from infants without siblings (M = 21.86; SD = 13.54), $t(18) = 1.91$, p =.036. H2.1, having siblings influences the social engagement during the task, could be confirmed.

Figure 12

Behavior of infants with siblings compared to infants without siblings throughout the whole task



Note. Insg_behavior = total behavior throughout the task; Siblings = 0 (not having siblings) vs. 1 (having siblings).

For the comparison of infants' social engagement with the groups "kindergarten attendance"/"no kindergarten attendance", another independent t-test was conducted. According to Shapiro-Wilk test, normal distribution was not given, p <.05. However, in accordance with the *central limit theorem* (Field, 2009), the analysis was carried out. The required assumption of variance homogeneity was tested with Levene's test. Variances were equal for both groups, $F(1,49) = .85$, $p = .36$. On average, social engagement of infants attending kindergarten ($M = 34.5$; $SD = 24.28$) did not significantly differ from infants not attending kindergarten ($M = 24.40$; $SD = 16.13$), $t(49) = 1.16$, $p = .25$. Therefore, H2.2 could not be confirmed.

4.2.2 Siblings and child-care facility influence attention

For the comparison of infants' attention in the groups "siblings"/"no siblings", an independent t-test was conducted. According to the Shapiro-Wilk test, normal distribution was not given, p <.05. However, in accordance with the *central limit theorem* (Field, 2009), the analysis was carried out. The required assumption of variance homogeneity was tested with Levene's test. Variances were equal for both groups, "siblings" and "no siblings", $F(1,49) = 1.19$, p =.28. On average, the attention of infants with siblings ($M = 225169.47$; $SD = 28981.18$) did not significantly differ from infants without siblings ($M = 230386.31$; $SD = 22646.96$), $t(49) = -.69$, p =.49. Consequently, H2.3, having siblings influences the looking time duration of an infant during the task, could not be confirmed.

For the comparison of infants' attention in the groups "kindergarten attendance"/"no kindergarten attendance", an independent t-test was conducted. According to the Shapiro-

Wilk test, normal distribution was not given, p <.05. However, in accordance with *the central limit theorem* (Field, 2009), the analysis was carried out. The required assumption of variance homogeneity was tested with Levene's test. Variances were equal for both groups, $F(1,49)$ = .16, p = .69. On average, attention of infants attending kindergarten (M = 26743.99; SD = 26743.99) did not significantly differ from infants not attending kindergarten (M = 228995.23; SD = 24601.09), $t(49)$ = -.14, p = .89. H2.4 could therefore not be confirmed.

4.3 Face mask and the influence on social engagement

For the comparison of infants' social engagement with the experimenter during the interaction phase with the groups pre- and post-pandemic, an independent t-test was conducted. According to Shapiro-Wilk test, normal distribution was not given, p <.05. However, in accordance with the *central limit theorem*, stating that sample sizes above 30 are large enough to assume normal distribution (Field, 2009), the analysis was carried out. The required assumption of variance homogeneity was tested with Levene's test. Variances were equal for both groups, $F(1,49)$ = .03, p = .87. On average, social engagement of infants during the interaction-phase in the pre-pandemic group (M = 3.14; SD = 2.97) did not significantly differ from infants in the post-pandemic group (M = 4.41; SD = 3.08), $t(49)$ = -1.02, p = .32.

Comparing infants' social engagement throughout the whole task with the groups pre- and post-pandemic, there was no significant result either ($t(49)$ = .84, p = .41). It could however be observed that infants in the pre-pandemic group engaged more throughout the task on average compared to infants in the post-pandemic group (M = 30.14; SD = 10.14) compared to the post-pandemic group (M = 24.41; SD = 17.59).

Comparing the frequencies at which the infant engaged with either the parent or the experimenter during the interaction-phase in the post-pandemic group, it can be seen that infants interact averagely more with the experimenters (M = 4.41; SD = 3.08) than with their parents (M = .41; SD = .82).

5. Discussion

The current study aimed to investigate the influence and dynamics of social engagement on looking time duration within a visual scene and furthermore examined if experiences in the social world in the form of siblings or attendance in child-care facilities have an impact on both social engagement and attention of infants from 11-13 months. The current worldwide global health crisis caused by Covid-19 and the accompanying appearance and constant presence of face masks made it possible to investigate how face masks would influence social engagement of infants during the task. Checking the frequencies of the different behaviors, it showed that there were clear differences between the forms of social engagement. Pointing was the most common form of social engagement of the infants throughout all three phases in this study which was expected given current literature (Bates et al., 1975; Beuker et al., 2013; Carpenter et al., 1998). As references state that vocalizing tends to accompany pointing when engaging socially (Lüke et al., 2017; Murillo & Belinchón, 2012), it was also expected that it would be the second most common form of social engagement. When initiating joint attention, infants tended to use both pointing and vocalizing. Infants were looking more frequently at the experimenter in the interaction-phase, even with the parent as their primary caregiver present. A possible explanation for this outcome could be that the infants were experiencing a novelty effect, as they were not yet too familiar with the experimenter. On the other hand, they already got to know the experimenter a bit beforehand during the warm-up phase, but as that was not a very long time the infants might still have been more interested in the ‘new’ person.

Regarding the first hypothesis (H1.1), it was assumed that social engagement would change over the course of the task and differ from phase to phase (pre-, interaction- and post-phase). In line with the current literature (), the infants were expected to engage more thoroughly with the experimenter during the interaction-phase because of the use of ostensive cues (pointing at screen and addressing the images). It was assumed that there would be significant differences between pre-phase vs. interaction-phase and pre-phase vs. post-phase. This was confirmed by the comparison of the social engagement during the pre-phase compared to the interaction-phase and the comparison of social engagement during the pre-phase compared to the post-phase. Results also showed that the infants engaged most with their environment during the interaction phase. The results seem to confirm that with the help of ostensive cues (Csibra & Gergely, 2009; Senju & Csibra, 2008), infants show more responsiveness regarding a third object (interaction-phase) and are more likely to initiate engagement themselves afterwards (post-phase).

Hypothesis 1.2 investigated the impact of social engagement on the factor of attention. Considering the literature, it was assumed that social engagement would significantly influence attentional processes during the task (e.g., Hoehl & Striano, 2013; Reid and Striano, 2005). This hypothesis was partially confirmed. Two moderately negative correlations were found throughout the task for the variables social engagement and looking time, as were social engagement during the pre-phase and looking time duration during the pre-phase. Possible explanations for these outcomes could be that in the pre-phase the infants were still getting used to the situation and would engage less. As the study situation was also a new environment and there were some infants who would need more motivation and time until getting ready for the experiment, they would seek comfort after the start of the experiment and would show some kind of novelty effect since during the interaction-phase and post-phase the correlation was not significant anymore but the infants were engaging more. Analysis of the regression showed that in this study the more the infants would socially engage during the pre-phase and throughout the whole study, the less attention they would pay to the pictures on the screen. The results could be explained by the manner in which the infants displayed their behavior. If they were for example just looking at the picture and pointed or vocalized, they showed full attention to the picture (=full looking time duration). However, if they were pointing or vocalizing and trying to grab the attention of the parent or experimenter, they were sometimes looking at them and simultaneously moved their gaze away from the screen. Nevertheless, the infants were initiating joint attention even though they were not looking at the pictures for a long time. These findings show that infants who displayed a higher level of social engagement - even though the actual looking time was brief - were using their attentional processes to guide the attention of others to a third object, this being the screen in our study. They were thereby successfully practicing joint attention which further confirms the broad research on this topic already realized. As attention in this study was measured by looking time duration to the screen, the hypothesis could not fully be confirmed. For future research it would be interesting to measure attentional processes not only by looking time, but in additional ways to investigate the influence of social engagement on infants' attention.

In terms of siblings (H2.1), this study tested if they would influence the social engagement of infants in the study. It was assumed that social engagement of infants with siblings and social engagement of infants without siblings would differ significantly. Significant results strengthen this hypothesis, as infants with siblings engaged more socially throughout the whole task compared to infants without siblings. These results are quite interesting as the sample consisted of more infants without siblings than infants with siblings.

Even though the sample was not equal, the results showed that an infant having siblings impacts the social engagement they were showing in the study. Considering the literature, it makes sense that siblings influence the engagement of infants with their environment (Barr & Hayne, 2003; Barton & Tomasello, 1991; Lamb, 1978). As infants have a peer at home with whom they can play and actively interact and furthermore imitate certain actions, it is likely that they engage more outside of their own home, too. Moreover, the findings of Barton and Tomasello (1991) confirm this by showing that infants who have the opportunity to take part in triadic interactions with their mother and a sibling experience a richer learning environment. This research additionally indicates that these infants would learn how to engage socially while their siblings were present.

Hypothesis 2.2 investigated if attendance at a child-care facility has an impact on social engagement of the infants in the study. It was assumed that social engagement of infants with attendance in a child-care facility and social engagement of infants not attending a child-care facility would differ significantly. No significant differences could be found between the two groups. However, as the two groups tested had a different group size (4 infants in child-care facilities vs. 47 infants cared for at home), it was therefore difficult to obtain meaningful results. Infants of this age are still mostly cared for at home, as mothers in Austria are usually on maternity leave for the first year after giving birth, which would explain why there are so few infants attending child-care facilities. To obtain a more meaningful result, a larger, more balanced sample with more infants who attend child-care facilities would be necessary.

Hypothesis 2.3 took a closer look at the impact of the infants having siblings on the formers' attention. A significant difference in looking time duration during the task between infants with siblings and those without was assumed. However, no significant results were found, indicating that group differences were not strong enough to reach significance. As group sizes were unequal (15 infants with siblings, 36 without siblings), obtaining a meaningful result was difficult. In general, having siblings seems to have no effect on looking time duration during the task. A possible explanation could be that infants which are barely just one year old, they are mostly interacting with their mother while practicing attentional tasks. Comparing the results of this study in terms of siblings, it seems that siblings do have an impact on the level of social engagement an infant shows in a different environment when separated from their siblings, but they do not have an impact on the looking time duration during a specific task. While siblings have the role of the playing partner for the infant and infants tend to imitate their actions while monitoring them, the mother seems to play the role

of a ‘teacher’. She tries to create a rich learning environment for their babies by using various techniques (ostensive cues, infant-directed speech, etc.) intentionally (Aldrich et al., 2015; Bakeman & Adamson, 1984; Barton & Tomasello, 1991). Therefore, she probably has more impact on the attentional processes of infants than siblings.

Regarding hypothesis 2.4, it was assumed that attendance in a child-care facility would influence looking time duration in the task. However, there were no significant results found. As already mentioned earlier, it was difficult to obtain a meaningful result as the two groups were very unequal in size. A possible explanation for a non-significant result regarding this hypothesis could be that infants of the age of 11-13 months still spend most of their time and attention on their mother and less on other people and children around. Thus, the impact of attending a child-care facility or not can be neglected.

Hypothesis 3.1 investigated the impact of the experimenter wearing a face mask during the interaction-phase and if there would be a difference in social engagement between the pre-pandemic and post-pandemic group. On the basis of prior research, it was assumed that the face mask, as it covers half of the face of the experimenter, would have an influence on the social engagement of the infants in the post-pandemic group compared to the pre-pandemic group. However, no significant differences between the groups were found concerning social engagement.

This can be seen as a positive discovery in regard to the pandemic situation, as face masks do not negatively impact the behavioral development and engagement of an infant. Another explanation for there not being a difference can be because the infant already got to know the experimenter for a few minutes during the warm-up phase.

Although results remained non-significant, by analyzing the mean scores of the groups’ social engagement throughout the whole task, it can be seen that infants in the pre-pandemic group engaged on average more than infants in the post-pandemic group. This could be an indicator as to how the face mask can influence the social engagement in general in a sample with an equal group size. Unfortunately, the group sizes of this study were very unequal (7 infants in the pre-pandemic vs. 44 infants in the post-pandemic group) and therefore this result is not very meaningful.

Hypothesis 3.2 took a closer look at the question if infants in the post-pandemic group were engaging more with the parent or the experimenter during the interaction-phase. This hypothesis could not be confirmed, as the infants were on average engaging more with the experimenter than with their parent. This could be because of a novelty effect, meaning that the infants were more interested in looking at and engaging with the new social partner in the

form of the experimenter who sat directly next to the screen. In addition, the parents were instructed not to engage help the infants during the screen-looking task. Therefore the only person actively interacting with the infant was the experimenter. With help of ostensive cues, they showed more responsiveness and openness to them. Furthermore, the infants were sitting on their parent's lap facing the screen, so it would have been more difficult to interact directly with the parent than with the experimenter who was sitting next to the screen and directly in the infants' field of vision.

5.1 Limitations and future research

The following section deals with several limitations connected to the current study. A major limitation were the small and unequal group sizes of infants with or without siblings and attendance in a child-care facility or not. If having siblings and attending child-care facilities are expected to especially impact attention, future research should aim for more balanced group sizes. Furthermore, there was no fair balance between the two groups of pre-pandemic and post-pandemic. This group size imbalance resulted in there not being a meaningful conclusion, as no significant difference between the two groups could be observed.

There happened to be some limitations in the study situation as well. For example, the fact that parents should not actively try to direct the attention of their infants during the study session needs to be emphasised more heavily. A few infants were not paying a lot of attention to the images and the parents talked to them and pointed their finger to the screen with the intention to help them which was contradictory to the study. Even though the experimenter was intervening as soon as they noticed the behavior of the parents, the results were already biased.

Furthermore, the visual attention task was presented on a 17-inch stimulus CRT (cathode-ray tube) monitor. While observing the study sessions, it could be seen that some infants seemed to be more interested in the monitor as they tried to get closer and touch it and were therefore not looking at the images directly. Some parents also reported afterwards that their infants did not have or only very scarcely had experiences with television or computer screens and were therefore more interested in exploring the new object than paying attention to the images on screen. Therefore, for future studies, it may be necessary to gather information about the infants' experience with the gear used in the study before conducting any experiments.

Regarding the video coding, there were some difficulties identifying whether the infant was looking at the computer screen or if they were simply looking at the computer itself. As the slightest shift of their eyes was necessary to determine if they were looking at the images or somewhere else, it was sometimes difficult to decide at which coding point the infant started looking at the image or looked away. Moreover, the video camera which was used to record the study trials sometimes was placed at a problematic angle to the parent and the infant which made it difficult to directly see the eyes of the infant. For future research it might be necessary to discuss alternative or additional verification techniques.

5.2 Conclusion

Overall, the current study demonstrated that social engagement and attentional processes are related and influence each other in ways that are beneficial for an infant's development. With the help of joint attention and ostensive cues the infant is able to engage successfully with a social partner and learns fast to use these skills on their environment. Although the relation between social engagement and attention in the form of looking time duration was not as expected, the present results give cause to further investigate the relation between these two variables with different measures. Further assessment of the impact of siblings and child-care facilities with more balanced groups is recommended for future studies.

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Abstract (english)

Joint attention and the importance of social engagement on infants in their first year of life has been widely and broadly researched. Infants start engaging with their social environment in the form of pointing at objects, vocalizing or looking at social partners to grab their attention and focus together on a common object of interest. As most of the studies are about social partners engaging with infants, gaps remain in addressing the direct social engagement of the infant with their environment. The impact of the experimenter in the study wearing a face mask was investigated exploratorily.

To assess how social engagement of an infant (pointing, vocalizing, checking back with parent and experimenter) changes throughout a visual task and how it influences their attention on the task itself, the social behavior and looking time duration of 51 11–13-month-old infants was examined. The infants engaged mostly in the interaction-phase with the experimenter present and social engagement differed significantly comparing the pre-to the post-phase and the pre- to the interaction-phase. Social engagement predicted the looking time duration during the task: The more the infants engaged during the task, the less attention they paid. Additionally, having siblings seemed to have a positive impact on social engagement but not on the looking time duration. Child-care facility attendance neither had an effect on social engagement nor on looking time duration. Because of the unequal group sizes regarding siblings and child-care facilities, it would be recommended to repeat a similar study with equal group sizes and the considerations of the limitations in this study.

Abstract (german)

Die gemeinsame Aufmerksamkeit und die Bedeutung des sozialen Engagements für Säuglinge in ihrem ersten Lebensjahr sind umfassend erforscht worden. Säuglinge beginnen, sich mit ihrer sozialen Umgebung zu beschäftigen, indem sie auf Objekte zeigen, vokalisieren oder ihre Sozialpartner ansehen, um deren Aufmerksamkeit zu erregen und sich auf ein gemeinsames Objekt zu konzentrieren. Da sich die meisten Studien mit der Interaktion von Sozialpartnern mit Säuglingen befassen, bleiben Lücken bei der Untersuchung der direkten sozialen Interaktion des Säuglings mit seiner Umgebung. Der Einfluss des Experimentators, der in der Studie eine Gesichtsmaske trug, wurde exploratorisch untersucht. Um festzustellen, wie sich das soziale Verhalten eines Säuglings (Zeigen, Vokalisieren, Eltern und Versuchsleiter anschauen) während einer visuellen Studie verändert und wie es die Aufmerksamkeit auf die eigentliche Aufgabe beeinflusst, wurde das soziale Verhalten und die Dauer des Anschauens von 51 11-13 Monate alten Säuglingen untersucht. Die Säuglinge engagierten sich vor allem in der Interaktionsphase in Anwesenheit des Versuchsleiters, und das soziale Engagement unterschied sich signifikant im Vergleich zwischen der Prä- und Post-Phase und der Prä- und Interaktions-Phase. Das soziale Engagement sagte die Dauer des Anschauens während der Aufgabe voraus: Je mehr sich die Kinder während der Aufgabe engagierten, desto weniger Aufmerksamkeit schenkten sie der Aufgabe. Außerdem schien das Vorhandensein von Geschwistern einen positiven Einfluss auf das soziale Engagement zu haben, nicht aber auf die Dauer des Schauens. Der Besuch einer Kinderbetreuungseinrichtung wirkte sich weder auf das soziale Engagement noch auf die Dauer des Schauens aus. Aufgrund der ungleichen Gruppengrößen in Bezug auf Geschwister und Kinderbetreuungseinrichtungen wäre es empfehlenswert, eine ähnliche Studie mit gleichen Gruppengrößen und unter Berücksichtigung der Einschränkungen in dieser Studie zu wiederholen.

Appendix

Appendix A: self-report questionnaire on demographic data

Appendix A

VieJA: Hintergrund

ID:

Elternfragebogen

Bitte füllen Sie den Fragebogen möglichst vollständig und nach bestem Wissen aus. **Einige der unveränderlichen Angaben werden in der Datenbank hinterlegt, damit Sie dieselben Fragen bei einer weiteren Studienteilnahme nicht noch einmal ausfüllen müssen.** Alle Angaben sind selbstverständlich freiwillig und werden vertraulich behandelt.

Kind

1. Füllen Sie bitte folgende Informationen zu den Geburtsdaten Ihres Kindes aus:

Geburtsdatum: _____

Geschlecht: ☐ männlich ☐ weiblich

Schwangerschaftswoche: _____

Gewicht bei Geburt: _____ g

Körperlänge bei Geburt: _____ cm

Kopfumfang bei Geburt: _____ cm

APGAR Score: 1 Minute _____ 5 Minuten _____ 10 Minuten _____

Geburtsort: _____

Wie lange hat Ihr Kind bisher in Österreich gelebt? (Dauer in Monaten)

_____

Wie lange hat Ihr Kind bisher in anderen Ländern gelebt? (Dauer in Monaten)

_____

2. Gab es während der Schwangerschaft oder Geburt Auffälligkeiten oder Komplikationen (z.B. Diabetes, Frühgeburt, etc.)?

☐ ja ☐ nein ☐ unsicher

Wenn ja, welche?

_____

3. Hat(te) Ihr Kind ernsthafte oder chronische Erkrankungen?

☐ ja ☐ nein ☐ unsicher

Wenn ja, welche und in welchem Zeitraum:

_____

4. Hatte Ihr Kind jemals Sehstörungen?

☐ ja ☐ nein ☐ unsicher

Wenn ja, welcher Art?

_____

ID:

5. Hatte Ihr Kind jemals Hörstörungen, ernsthafte Ohrerkrankungen (z.B. Mittelohrentzündung) oder Ohroperationen (z.B. Paukenröhrchen)?

☐ ja ☐ nein ☐ unsicher

Wenn ja, welcher Art?

_____

6. Wurde Ihr Kind gestillt?

☐ ja ☐ nein ☐ unsicher

Wenn ja, bis zu welchem Monat? _____

7. Wer ist die Hauptbezugsperson des Kindes?

☐ Mutter ☐ Vater ☐ Andere Person: _____

8. Ist das Ihr erstes Kind? ☐ ja ☐ nein

Anzahl Geschwister: _____

Platz des Kindes in Geschwisterreihe: _____

Wie viele Personen leben in Ihrem Haushalt? _____

Bitte geben sie an, welche Personen in Ihrem Haushalt lebt:

	Beziehung zum Kind (z. B. Vater, Bruder)	Alter
1.		
2.		
3.		
4.		
5.		
6.		

9. Wenn Sie Interesse daran haben mit den Geschwistern Ihres Kindes (zwischen 0 und 6 Jahren) an anderen Studien teilzunehmen:

Vorname & Geburtstag:	
Vorname & Geburtstag:	

ID:

10. Besucht Ihr Kind einen Kindergarten oder wird es von einer Tagesmutter/einem Tagesvater betreut?

☐ Kindergarten ☐ Tagesmutter/ -vater ☐ nein

11. Wie hoch ist das ungefähre monatliche Haushaltseinkommen (netto)?

☐ < 1000€ ☐ 1000-1500€ ☐ 1500-2000€ ☐ 2000-2500€ ☐2500-3000€ ☐ > 3000€

Eltern

Angaben zur Mutter:

1. **Geburtsdatum:** _____
2. **Geburtsort:** _____
3. **Nationalität:** _____
4. **Wie lange haben Sie bisher in Österreich gelebt (Dauer in Jahren, ev. Monaten)?** _____
5. **Sind Sie, ihre Eltern oder Ihre Großeltern aus einem anderen Land nach Österreich eingewandert?** ☐ ja ☐ nein

   Wenn ja, woher? _____

   Wer ist eingewandert? ☐ Sie ☐ Ihre Eltern ☐ Ihre Großeltern

   Falls Sie selbst nach Österreich gezogen sind, vor wie vielen Jahren war das? _____

   Ist Ihr(e) Partner(in), seine/ihre Eltern oder seine/ihre Großeltern aus einem anderen Land nach Österreich eingewandert? ☐ ja ☐ nein

   Wenn ja, woher? _____

   Wer ist eingewandert? ☐ Ihr(e) Partner(in) ☐ Seine/ihre Eltern ☐ Großeltern

   Falls er/sie selbst nach Österreich gezogen ist, vor wie vielen Jahren war das? _____
6. **Muttersprache(n):** _____
7. **Welche Sprache(n) verwenden Sie im Umgang mit Ihrem Kind hauptsächlich?**

   _____
8. **Händigkeit:** ☐ Linkshändigkeit ☐ Rechtshändigkeit ☐ Beidhändigkeit

VieJA:

ID:

9. **Höchster Bildungsabschluss:**

   ☐ Ohne ☐ Pflichtschule ☐ Lehre, BMS ☐ BHS ☐ AHS
   ☐ Kolleg, Fachlehrgang ☐ Universität, Hochschule

10. **Erlernter Beruf/ Studienabschluss:** _____

11. **Aktuelle Tätigkeit:** _____

12. **In welchem Beschäftigungsverhältnis befanden Sie sich vor der Karenzzeit (falls zutreffend)?**

    ☐ Schülerin ☐ Auszubildende ☐ Studentin ☐ Angestellte ☐ Beamte
    ☐ Selbstständig ☐ Arbeitslos/-suchend ☐ Sonstiges ☐ Trifft nicht zu

13. **Wohnsituation:**

    ☐ alleinerziehend ☐ zusammenlebend ☐ zusammenlebend mit neuem Partner/neuer Partnerin

    ☐ Sonstiges: _____

Angaben zum Vater:

1. **Geburtsdatum:** _____
2. **Geburtsort:** _____
3. **Nationalität:** _____
4. **Muttersprache(n):** _____
5. **Welche Sprache(n) verwendet er im Umgang mit Ihrem Kind hauptsächlich?**

   _____

6. **Händigkeit:** ☐ Linkshändigkeit ☐ Rechtshändigkeit ☐ Beidhändigkeit

7. **Höchster Bildungsabschluss:**

   ☐ Ohne ☐ Pflichtschule ☐ Lehre, BMS ☐ BHS ☐ AHS
   ☐ Kolleg, Fachlehrgang ☐ Universität, Hochschule

8. **Erlernter Beruf/ Studienabschluss:** _____

9. **Aktuelle Tätigkeit:** _____

10. **In welchem Beschäftigungsverhältnis befanden Sie sich vor der Karenzzeit (falls zutreffend)?**

    ☐ Schüler ☐ Auszubildende ☐ Student ☐ Angestellte ☐ Beamter
    ☐ Selbstständig ☐ Arbeitslos/-suchend ☐ Sonstiges ☐ Trifft nicht zu

ID:

11. Wohnsituation:

☐ alleinerziehend ☐ zusammenlebend ☐ zusammenlebend mit neuem Partner/neuer Partnerin

☐ Sonstiges: _____

Weitere Sprachen, die in der Familie gesprochen werden:

_____

Bitte füllen Sie den folgenden Teil nur aus, wenn ihr Kind eine andere Hauptbezugsperson hat außer Mutter oder Vater:

Angaben zur Hauptbezugsperson des Kindes (falls zutreffend):

1. **Geburtsdatum:** _____
2. **Geburtsort:** _____
3. **Nationalität:** _____
4. **Muttersprache(n):** _____
5. **Ist er/sie, seine/ihre Eltern oder seine/ihre Großeltern aus einem anderen Land nach Österreich eingewandert?** ☐ ja ☐ nein
6. **Wenn ja, woher?** _____
7. **Wer ist eingewandert?** ☐ Er/sie ☐ Seine/ihre Eltern ☐ Großeltern
8. **Falls er/sie selbst nach Österreich gezogen ist, vor wie vielen Jahren war das?** _____
9. **Welche Sprache(n) verwendet er im Umgang mit Ihrem Kind hauptsächlich?**

   _____

10. **Händigkeit:** ☐ Linkshändigkeit ☐ Rechtshändigkeit ☐ Beidhändigkeit
11. **Höchster Bildungsabschluss:**

    ☐ Ohne ☐ Pflichtschule ☐ Lehre, BMS ☐ BHS ☐ AHS
    ☐ Kolleg, Fachlehrgang ☐ Universität, Hochschule

12. **Erlernter Beruf/ Studienabschluss:** _____
13. **Aktuelle Tätigkeit:** _____
14. **In welchem Beschäftigungsverhältnis befanden Sie sich vor der Karenzzeit (falls zutreffend)?**

    ☐ Schüler(in) ☐ Auszubildende ☐ Student(in) ☐ Angestellte ☐ Beamte(r)
    ☐ Selbstständig ☐ Arbeitslos/-suchend ☐ Sonstiges ☐ Trifft nicht zu

ID:

15. Wohnsituation:

☐ alleinerziehend ☐ zusammenlebend ☐ zusammenlebend mit neuem Partner/neuer Partnerin

☐ Sonstiges: _____