



Understanding the self in relation to others: Infants spontaneously map another's face to their own at 16–26 months

Dora Kampis¹  | Charlotte Grosse Wiesmann^{1,2} | Sarah Koop³ | Victoria Southgate¹

¹ Centre for Early Childhood Cognition, Department of Psychology, University of Copenhagen, Copenhagen, Denmark

² Minerva Fast Track Research Group Milestones for Early Cognitive Development, Max Planck Institute for Human Cognitive and Brain Sciences, Leipzig, Germany

³ Institute for Psychology, Humboldt University Berlin, Berlin, Germany

Correspondence

Charlotte Grosse Wiesmann, Centre for Early Childhood Cognition, Department of Psychology, University of Copenhagen, Copenhagen, Denmark.

Email: wiesmann@cbs.mpg.de

Dora Kampis and Charlotte Grosse Wiesmann contributed equally to this study.

Abstract

The current study probed whether infants understand themselves in relation to others. Infants aged 16–26 months ($n = 102$) saw their parent wearing a sticker on their forehead or cheek, depending on experimental condition, placed unwitnessed by the child. Infants then received a sticker themselves, and their spontaneous behavior was coded. Regardless of age, from 16 months, all infants who placed the sticker on their cheek or forehead, placed it on the location on their own face matching their parent's placement. This shows that infants as young as 16 months of age have an internal map of their face in relation to others that they can use to guide their behavior. Whether infants placed the sticker on the matching location was related to other measures associated with self-concept development (the use of their own name and mirror self-recognition), indicating that it may reflect a social aspect of children's developing self-concept, namely their understanding of themselves in relation and comparison to others. About half of the infants placed the sticker on themselves, while others put it elsewhere in the surrounding, indicating an additional motivational component to bring about on themselves the state, which they observed on their parent. Together, infants' placement of the sticker in our task suggests an ability to compare, and motivation to align, self and others.

KEYWORDS

self-other alignment, self-other comparison, self-other map, self-other relation, social self, sticker task

1 | INTRODUCTION

The ontogenetic origin of self-representation is a fundamental question in the study of early cognitive development. An uncontroversial answer to this question has been impeded by the multifaceted character of the self. While research in the first year of life has mainly focused on infants' perception of their own body – sometimes referred to as *bodily self* (e.g., Bahrack, 2013; Filippetti et al., 2015a, 2013; Marshall

& Meltzoff, 2015), others have proposed that a more conceptual self-representation develops through the interaction with others in the second or third year of life (e.g., Musholt, 2012; Rochat, 2010). The latter view follows a tradition of thinking in which the self-concept entails an awareness of the self as distinct from, but in relation to, others (Mead, 1934). According to this view, one can only become an object of one's own reflection by thinking of oneself from an outside perspective, that is, as seen by others (Mead, 1934; Musholt, 2012; Rochat, 2010). In

This is an open access article under the terms of the [Creative Commons Attribution-NonCommercial](https://creativecommons.org/licenses/by-nc/4.0/) License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes.

© 2021 The Authors. *Developmental Science* published by John Wiley & Sons Ltd



the present study, we aimed at probing infants' understanding of themselves in relation to others by investigating whether infants seek to bring about physical similarity between self and others.

The ability to see one's physical resemblance to others entails an understanding of the correspondence between self and other body parts. Some evidence suggests that precursors of such a map may already be present at birth. In a series of studies, newborns preferred to look at another infant's face stroked in synchrony with their own face compared to asynchronous stroking, and preferred anatomically congruent to incongruent stroking (Filippetti et al., 2013, 2015a, 2015b). This early ability for multi-sensory integration has been argued to provide a potential precursor for self-perception (Bahrick, 2013), by allowing one to identify sensory input that refers to one's own senses (e.g., seeing and feeling that one is being stroked). Towards their second year of life, infants are able to successfully reach for a tactile stimulation on their own body (Leed et al., 2019), extending findings of multi-sensory integration to the tactile-proprioceptive domain. In addition, while perfect multi-sensory synchrony may allow identifying sensory input that refers to one's own senses, differences in multi-sensory information in turn may support a potential differentiation between self-touch and touch by another person in newborns (Rochat & Hespos, 1997), providing a potential precursor of self-other differentiation.

This 'subjective' understanding of self can be seen in contrast to an objective self-awareness (Duval & Wicklund, 1972; Moore, 2007). While the studies discussed above address precursors of a multi-sensory, bodily self and its distinction from others' bodies (subjective self-awareness), much less is known about how infants come to understand themselves in relation to others, whether and when they are able to compare self and other, and are motivated to align with others (objective self-awareness). For infants, seeing themselves in relation to others and engaging in self-recognizing in interactions by detecting how others respond to them, has been proposed to be an essential contributor to moving from a more bodily self to a self *proper* (Rochat, 2013). This self proper is proposed to have referential 'aboutness': it can be understood as an object of thought, something one (others or oneself) *can think (or talk) about* (Bates, 1990; Rochat, 2013) and potentially form memories of (Howe et al., 2003; Povinelli, 1995). It has been argued that this is a step that eventually contributes to understanding the self as a person who is in comparative and normative relation to others (Rochat, 2009). Some suggestion that infants may already detect the relationship between self and others comes from recognizing when they are being imitated or in imitating others. For example, infants who pass the mirror self-recognition task engage in more imitation than infants who do not, suggesting that imitation may involve an appreciation of the self (Asendorpf & Baudonnière, 1993; Asendorpf et al., 1996; Zmyj et al., 2013). Furthermore, infants from around 14–18 months discriminate between a person who imitates their action and an object that brings about the same state they did (Agnetta & Rochat, 2004), again suggesting that at this age they might be able to detect similarity between their own and others' actions. However, the mechanisms behind imitation and detection of imitation are debated and need not necessarily reflect a conceptual understanding of self versus other (e.g., Anisfeld, 1991; Heyes, 2011; Jones, 2009).

RESEARCH HIGHLIGHTS

- In the newly developed "sticker task," we probed 16-26-month-old infants' understanding of themselves in relation to, and motivation to align with, others.
- Infants saw their parent wearing a sticker on their cheek or forehead, and were offered then a sticker themselves, whereupon their spontaneous behavior was observed.
- All infants who placed the sticker on their cheek or forehead, placed it on the location matching that of their parent's sticker.
- Matching placement was related to infants' use of their own name and mirror-self-recognition, indicating its relation to self-concept development.

The ability to detect similarities and differences between self and others – or self–other comparison – is central to understanding the self in relation to others and may be a prerequisite for a motivation to align self with others. Self–other comparison is relevant not just in the context of understanding the development of the self, but also when thinking about the self in interaction with others. To compare the self with others, identify differences, and seek to bring about alignment is foundational for important aspects of our social cognition, including our social preferences (e.g., Tajfel & Turner, 1979). From around 2 years of age, children's self-directed behavior has been shown to depend on their social environment (Broesch et al., 2011; Rochat et al., 2012). For example, while 2-year-old children typically touch or try to remove a previously unnoticed mark on their face when seeing themselves in the mirror in the classic *mirror mark test* (Amsterdam, 1972), they did this less often when the others around them also wore the same mark on their face (Rochat et al., 2012).

Moreover, to date much evidence suggests that infants prefer others who share some characteristic with the infants themselves, including their language and their preferences. For example, infants prefer to choose puppets offered to them by speakers of their own native language (Kinzler et al., 2007) or puppets who make the same food or color choices as the infant has made (Mahajan & Wynn, 2012), and preschoolers prefer others who have a facial resemblance to themselves (Richter et al., 2016). While a preference for others is a form of social alignment, it is unclear from these studies whether behavior derives from a comparison of others with self, or rather a preference for familiarity (Bergus et al., 2016). For example, both one's native language and one's own face is a highly familiar input and may drive infant and young children's preferences for others displaying these familiar characteristics.

In the current study, we avoided the ambiguity of preference as an indicator of self–other comparison and social alignment, and used the behavior of physical alignment. Rather than using preference as an indicator that infants may have detected that others act like them, we asked whether infants themselves would act to be more like others.

We reasoned that a motivation to look like others by spontaneously emulating their appearance on oneself would unambiguously indicate the process of self–other comparison and alignment. Specifically, when we try to look like others, it entails that we compare self and others, have understood that the other is different from us, and are motivated to align the self with the other. In the present study, we wanted to tap into this social dimension of the self, and probe whether it may be related to other markers of self-concept development, such as mirror self-recognition and the use of verbal self-reference. We asked whether infants are able not only to understand the correspondence between self and others, but also to act upon this correspondence. In particular, we wanted to probe whether infants are able and motivated to use their self–other map to actively intervene in order to align the self with the other.

Combining these different aspects of understanding the self in relation to others (i.e., infants' active self–other map, their ability for self–other comparison, and motivation to align with others), we developed a novel task probing infants' readiness to *emulate* a state observed on their parent's face by acting on their own face in correspondence, without seeing how this state came about and thus without having the opportunity to imitate their parent's actions. This was intended to ensure that infants did not merely copy observed actions, but instead reenacted the parent's appearance on themselves, out of a motivation to look like them. Importantly, unlike in the mirror mark test, the child's own face and their actions on it remained visually inaccessible to them, to probe the presence of an *internal* map of the self in relation to others and the ability to act on oneself using this map without visual feedback (e.g., of a mirror) or guidance (e.g., by imitating their parent's action). Moreover, rather than seeing a mark on their own face in their perfectly synchronous mirror image, the mark was placed on another person, thus tapping into infants' social understanding of the self in relation to others.

In this preregistered study, infants (aged 16–26 months) saw their parent with a sticker on their face, which had been placed in the infant's absence, either on the parent's cheek or their forehead depending on experimental condition. The infant was then offered to choose a sticker, and we observed whether infants spontaneously placed the chosen sticker on the corresponding location on their own face. We reasoned that such a behavior would indicate (1) the presence of an internal map of the infant's own facial features in correspondence to the other's face and the ability to act on their own face accordingly, (2) the infant's ability to compare self and other and motivation to align their own appearance to a state observed on their parent, reflecting a social dimension of the self.

We predicted that infants would show this behavior in their second year of life when other indicators of self-concept, such as mirror self-recognition and verbal self-reference, develop (e.g., Lewis & Ramsay, 2004; Rochat et al., 2012; Stipek et al., 1990). Additionally, we administered the classic mirror mark test and a parental questionnaire on infants' use of their own name and personal pronouns and hypothesized that infants' self–other mapping behavior would be related to these other measures of a developing self-concept.

2 | METHODS

The study was preregistered on the Open Science Framework, the description of the testing protocol, testing materials, and planned analyses can be found here: [https://osf.io/7ut9k/?view_only=a9b5146f960f456bb95f791edce614a1]. All materials and the dataset are available here: [https://osf.io/sqhyp/?view_only=4587bb27e189442089534444e89ba76d].

2.1 | Participants

In the sticker task 102 Danish speaking children between 16 and 26 months of age were included, and a further 27 participated but were excluded from the analyses due to fussiness (3), technical problems with the video recording (7), parental interference (11) or because they refused to take the sticker (6). Of the 102 children included in the sticker task (age: 16.0–26.4 months, median: 20.9 months; interquartile range (IQR) = 5.4 months; 59 (58%) female), 79 children also successfully participated in a mirror self-recognition task before the sticker task (age: 16.3–26.4 months, median: 21.4 months; IQR = 5.7 months; 46 (58%) female). Mirror test data for the other 23 children could not be included because of technical or video problems (3), insufficient mark saliency or other errors in the protocol (7), missing compliance (3), parental interference (1), or because they did not complete the mirror test (9). A parent questionnaire on verbal self-reference was obtained for 91 of the 102 children (age: 16.3–26.4 months, median: 20.9 months, IQR = 5.5 months; 52 (57%) female). More data were collected than planned at preregistration, but the results in the preregistered first $N = 72$ participants are highly comparable as reported in the Supplemental Information (SI; for a sample description of the first $N = 72$ and results, see SI Section 2.1 Table S2a, 2b).

Testing took place at two testing locations: in the lab and in a local science museum (for further details see SI, Section 1.1). At the science museum, infants were recruited through approaching the families on-site. In the lab, participants were recruited through the national birth registry of Copenhagen. Participants were predominantly from white middle-income families, reflective of the local population and those who responded to the invitation to participate. The study was approved by the Ethics Committee of the Department of Psychology at the University of Copenhagen, and parents signed an informed consent prior to participation.

2.2 | Sticker task

2.2.1 | Procedure

First, the parent received an envelope with a sticker and written instructions (see here: [https://osf.io/3fvua/?view_only=4587bb27e189442089534444e89ba76d]) to place the sticker on their face unbeknownst to the child. Parents were randomly assigned to one of two conditions, acting as controls for one another: $n = 61$ parents were asked to place the sticker on their cheek (children's age:



range: 16.0–26.1 months, median = 20.6 months, IQR = 5.5 months, 37 (61%) female) and $n = 41$ (16.3–26.4 months, median = 21.6 months, IQR = 5.0 months, 22 (54%) female) to place it on their forehead. Administering these two conditions controlling for each other allowed to test whether infants placed the sticker on the specific location on their face observed on their parent, and thus to ensure that they did not show this placing behavior without the corresponding model. After parents had placed the sticker, they were told to briefly and naturally interact with their child, without drawing attention to the sticker or referring to it in any way, and while making sure their child could not remove the sticker from their face. Once children noticed the sticker on their parents' face, the experimenter presented them with two other stickers (one identical to their parent's sticker, and a different one, see SI Section 1.2 Figure S1), and encouraged them to pick one. If the child did not make a choice, the experimenter gave them the identical sticker ($N = 1$). Then, children's behavior was observed. If children spontaneously placed the sticker on their cheek or forehead within the first 2 min after taking a sticker, the experiment was finished. Otherwise, after 2 min, the experimenter asked them what to do with the sticker, up to three times with increasing specificity ("What should we do with the sticker?", "Where should it go?", "Where should we put the sticker, should we put it on you?"). Infants' behavior was video recorded for later analysis. More details on the experimental procedure are provided in SI Section 1.3.

2.2.2 | Coding

Children's spontaneous behavior was analyzed with respect to (i) whether the child pointed to their own face after seeing the sticker on their parent, (ii) which sticker the child chose (identical vs. different one), and (iii) whether and where they placed the sticker on their own face (cheek (side disregarded) vs. forehead vs. other; where 'other' indicated placing anywhere else than cheek or forehead, or no placement at all). We also analyzed whether children placed the sticker on their cheek or forehead spontaneously or after one of the three prompts. Children in the cheek condition were further analyzed with respect to whether they placed it to the same or mirrored cheek as the parent's sticker. Finally, for comparison with the mirror mark test and use of verbal self-reference, children received a score of 1 for placing the sticker to the matching location and 0 for placing it elsewhere or not placing the sticker at all. The videos of 40 children (i.e., 39%) were coded by a second coder. In case of disagreement, a third coder was involved, and the final score was decided by the majority. The coders agreed on the matching placement in 100% of the cases.

2.3 | Mirror mark test

2.3.1 | Procedure

We conducted a mirror mark test (following the procedure of Bulgarcelli et al., 2019; see also Amsterdam, 1972) to assess children's ability

to recognize themselves in the mirror. The testing procedure included four phases: exposure and familiarization with the mirror prior to mark application (phase 1); mark application phase with occluded mirror (phase 2); second exposure to the mirror with the child having a mark on their face (phase 3); and finally, the experimenter pointing to the child's reflection in the mirror and asking "Who is that?" (phase 4). The mark was either applied to the cheek or nose (in 65% on the nose).

2.3.2 | Coding

Children's reactions to the mirror were coded with respect to whether they touched the mark in phase 3 (mark-directed behavior) and whether they vocalized any verbal self-reference when seeing themselves in the mirror in phase 3 or on request in phase 4. Children were assigned 1 for passing the mirror test (i.e., showing mark-directed behavior, using first-person pronouns, or using their own name) and 0 for not passing. None of the children touched the mark in phase 2 before seeing themselves in the mirror.

2.4 | Questionnaire

Parents filled out a short questionnaire with basic demographic data (e.g., age, siblings, language(s) of the child), questions on self-related language use (i.e., personal pronoun use, use of own name), and experience (e.g., with mirrors or cameras); the original questionnaire in Danish and English language can be found here: [OSF Link].

3 | RESULTS

The dataset is publicly available here: [OSF Link].

3.1 | Sticker placement

For the main analysis of interest, a Fisher's exact test was used to investigate the probability of children placing the sticker on their own face differentially depending on condition. This test was conducted instead of the preregistered multinomial logistic regression because of the occurrence of zero cell sizes. The two conditions acted as control groups for one another, yielding a baseline for how often children might put a sticker on their cheek (or forehead) without seeing the sticker on that location on their parent. In the forehead condition, 17/41 children (41%) placed the sticker on their own forehead and none on their cheek, and in the cheek condition 33/61 (54%) placed it on their own cheek and none on their forehead (Fischer's exact test $p < 0.001$; Cramer's $V = 0.69$; for a summary see Table 1, and SI Section 2.2 Table S3 for detailed description of "Other" placement responses), indicating that children who placed the sticker on their face had a correct map of their own face in relation to the face of their parent. Children placed the sticker on the respective matching location similarly often in

TABLE 1 Children's sticker placement in the two conditions (parent placement forehead vs. cheek)

Parent	Child			Total
	Forehead	Cheek	Other	
Forehead	17	0	24	41
Cheek	0	33	28	61
Total	17	33	52	102

TABLE 2 Relation between children's behavior in the sticker task and their performance in the mirror mark test

Sticker placement	Mirror test		Total
	Pass	Fail	
Matching	32	8	40
None	24	15	38
Total	56	23	79

both conditions, that is, there was no significant difference regarding matching sticker placement between the two conditions (forehead and cheek; $X^2(1, N = 102) = 1.1, p = 0.294$). Forty-five out of 50 children (88%) who placed the sticker on their cheek or forehead did so spontaneously after receiving it, the remaining six children placed it after the prompt by the experimenter (see SI section 2.3 Table S4). An additional five children pointed to the matching location on their own face but did not place the sticker accordingly. Two children pointed to a nonmatching location on their face (for further analyses of pointing location see SI Section 2.7 Table S8).

In the cheek condition, we analyzed whether children placed the sticker on, or pointed to, the same or the mirrored side of their face. In their sticker placement, children placed the sticker about equally often to the same and the mirrored side (exact binomial test, with "same cheek" as "success" category; $N = 32, K = 18, p = 0.298$, probability of success = 0.56, 95% CI = [0.4, 1]), whereas in their pointing, children pointed to the mirrored cheek more often (exact binomial test, with "mirrored cheek" as "success" category; $N = 10, K = 9, p = 0.011$, probability of success = 0.90, 95% CI = [0.6, 1]).

3.2 | Relation of sticker task with mirror mark test and verbal self-reference

Children who placed the sticker to the matching location also tended to pass the mirror task ($X^2(2, N = 79) = 3.261, p = 0.035$, one-sided Chi-square test, for a summary see Table 2). To test whether there might have been an effect of the mark in the mirror task on children's sticker placement, we tested whether the location of the mark in the mirror test (cheek or nose) had an effect on children's sticker placement in the sticker test, in particular in the cheek condition. This showed that children in the cheek condition were not more likely to place the sticker on their cheek when the mark in the preceding mirror task was on the cheek rather than the nose ($X^2(1, N = 48) = .738, p = 0.39$). We further assessed children's ability to verbally refer to themselves and found a

significant relation between matching sticker placement and the child's use of their own name ($X^2(1, N = 91) = 4.361, p = 0.038$, Chi-square test), but not their use of first-person pronouns ($X^2(1, N = 91) < 0.001, p = 0.992$, Chi-square test; for details see SI Section 2.4 Table S5a–5i).

3.3 | Choice

Out of 102 children 58 chose the identical sticker (57%), showing no significant preference for the sticker identical to their parent's sticker (exact binomial test, with "choice of same sticker" as "success" category; $N = 102, K = 58, p = 0.099$, probability of success = 0.57; 95% CI = [0.48, 1]). Children who chose the identical sticker were not more likely to place the sticker on the matching location (exact binomial test, with "matching placement" as "success" category; $N = 58, K = 30, p = 0.448$, probability of success = 0.52, 95% CI = [0.4, 1]).

3.4 | Effect of age

To assess whether age had an effect on the probability of placing the sticker to the matching location, we entered age (in months) as a continuous predictor in a binary logistic regression model with placement as a binary outcome variable (matching vs. nonmatching/no placement). This yielded no increase in successful sticker placement with age ($X^2(1, N = 102) = 0.996; p = 0.319; B = 0.066; SE = 0.066; 95\% CI = [-0.064, 0.196]$, reference category 0, that is, "nonmatching/no placement," see SI Section 2.5 Figure S2a). The relation between age and mirror self-recognition was $X^2(1, N = 79) = 3.529; p = 0.060; B = 0.161; SE = 0.086; 95\% CI = [-0.007, 0.329]$, between age and first person pronoun use was $X^2(1, N = 91) = 13.276; p = 0.000; B = 0.367; SE = 0.101; 95\% CI = [0.17, 0.565]$, and age and use of own name was $X^2(1, N = 91) = 13.94; p = 0.000; B = 0.348; SE = 0.093; 95\% CI = [0.165, 0.531]$. For details and results of the relation between age and other personal pronoun variables see SI Section 2.5 Figure S2b. We further conducted the main analyses in the two preregistered age groups separately (16–21.5 months and 21.5–26 months), which yielded similar results to those of the whole sample, and no differential effects in the two age groups (see SI Section 2.5 Table S6a–6d, Figure S3).

To test whether the relation between sticker placement and passing the mirror test changed with age, we added the mirror test (pass or no pass) as an additional factor to the binary logistic regression. This yielded no significant interaction between mirror test performance and age in months ($p = 0.241; B = 0.083; SE = 0.071; 95\% CI = [0.947, 1.251]$, reference category 0, i.e., "nonmatching/no placement"). Furthermore, adding gender and condition as variables to the logistic regression yielded no effect of gender or sticker condition (cheek or forehead) on infants' placement (for details see SI Section 2.6 Table S7).

4 | DISCUSSION

In the present study, 16- to 26-month-old infants saw their parent with a sticker on their face, either on the forehead or the cheek, depending



on condition. After receiving a sticker themselves, many children spontaneously placed it on their own cheek or forehead, and all children who did so placed the sticker on the matching location on their own face. No child placed the sticker to the location of the respective control condition (i.e., no child in the cheek condition placed a sticker on the forehead and vice versa), yielding a highly significant differential placement depending on condition. Moreover, very few (5 children out of 102) placed the sticker elsewhere on their face, showing that such behavior is unlikely to occur coincidentally without a model. Infants placed the sticker differentially from 16 months with no increase with age. This indicates that the understanding of the correspondence between self and others, is likely in place from at least 16 months of age. About half of the infants placed the sticker on their face, and the other half elsewhere in the surrounding, suggesting an additional motivational component to bring about the state on themselves that they observed on their parent. Children's placement of the sticker to the matching location was related to established measures of self-concept development (i.e., passing the mirror mark test and infants' use of their own name), indicating that this matching behavior may reflect children's developing self-concept.

All the infants who placed the sticker on their cheek or forehead, placed it on the matching location where they had observed it on their parent, and did so in the absence of any visual feedback. This suggests that they had an internal representation of their face, a visually inaccessible body part, and understood its correspondence to their parent's face. Infants were able to use this map to act on themselves to bring about correspondence with the state observed on their parent. The present study thus extends previous findings of multisensory contingency detection (e.g., Filippetti et al., 2015b; Leed et al., 2019) by showing that infants actively understand this correspondence, and that they are able to act upon it without multisensory contingency or feedback. As infants did not see how the parent's sticker was put on, they had no opportunity to imitate the parent's action to guide their own action. This is important because infants may have been motivated to imitate the action of placing a sticker on their face even if they had not engaged in any self–other comparison. Rather, in spontaneously emulating the outcome without any prior observation of how this outcome was achieved (Want & Harris, 2002), it implies that infants were motivated to align their appearance to the appearance of others. This motivation to create a similarity between self and other implies that infants detected a difference between self and other, suggesting that they engaged in a process of self–other comparison. Contrary to our predictions, out of two stickers, children did not choose the same sticker as their parent above chance level. One reason for this might have been that seeing the parent with a sticker on their face was considerably more novel and salient than the difference between the two stickers.

While the vast majority of infants who placed the sticker on their face did so without any prompt, half of the infants tested in the current study did not place the sticker on their face at all. It is important to note that because infants were not given any instructions or task, they could understand the situation in various ways and may have had different motivations. To show this matching behavior, infants had to be spon-

taneously motivated to bring about the state observed on their parent on themselves, and thus align their own appearance to the appearance of their parent. The positive relation of their sticker placement with infants' use of their own name and mirror self-recognition suggests a common element between intervening to look like the other in the sticker task and detecting or acting on the mark in the mirror task. One possibility is that this common element could be related to the capacities underlying the two tasks. The fact that the majority of children who placed the sticker to the matching location also passed the mirror task (80%), and only 10% of children failed the mirror task but placed the sticker in the matching location (see Table 2) could indicate that the capacity underlying mirror self-recognition may in part drive detecting the difference between self and other or the propensity to act on it. While mirror self-recognition increases with age in the tested age range, infants' tendency to place the sticker on the matching location on their face did not. It may be the distinct motivational aspect of the sticker task, namely the motivation to engage in self–other comparison and align with the other, that does not change with age. For example, there may be a propensity of self-recognizers to intervene on themselves in response to appearing differently from others. Alternatively, and perhaps more likely, the sticker and the mirror task may have a common motivational component related to the self in relation to others (to add the sticker in the sticker task and to remove the mark in the mirror task, in both cases to be more like the other person) and it could be this, which drives the relation between the two behaviors. Indeed, the mirror mark test has previously been found to be sensitive to social context, whereby toddlers were less likely to remove a mark from their forehead if others around them also wore a similar mark, even though many noticed and referred to the mark (Rochat et al., 2012), a modulation that may vary depending on culture (Broesch et al., 2011). A relation between the mirror mark test and infants' sticker placement fits with this potential social aspect of the mirror mark test, suggesting it taps into a social dimension of the self, namely how children see themselves in relation to others. In the present study, infant's own parents were chosen as models to increase the likelihood of eliciting children's affiliative motives. An interesting avenue would be to investigate inter-individual differences in relation to children's varying temperaments (e.g., shyness and other self-conscious emotions), as well as their behavior as a function of the identity of the other person (e.g., familiar or unfamiliar; or ingroup/outgroup).

The classic mirror mark test involves identifying the location of the mark seen in the mirror as a mark in the corresponding location of infants' own body, whereas the current task probed infants' understanding of the self in relation to others. The ability to compare self and other is an important social cognitive skill and lies at the heart of phenomena like minimal group preferences (Tajfel & Turner, 1979). Yet there has, to date, been little clear evidence concerning when this self–other comparison ability emerges in development. One previous study showed that 11-month-old infants prefer to play with a puppet who chooses the same-colored mittens as the infant chose (Mahajan & Wynn, 2012). While this may indicate that infants detected the similarity between self and other and preferred the other who liked what

the infant liked, it is also possible that infants like puppets who exhibit preferences that the infants themselves value more highly. Consistent with this explanation, infants did not prefer a puppet with whom they shared mitten color if the infant themselves did not have a choice which mitten color they wore. In the current study, not only did infants act spontaneously to bring about similarity between self and other, but in order to be motivated to bring about this similarity, they had to detect a difference: the other has a sticker but they do not.

From a broader perspective, self-other comparison and alignment is not only relevant for social preferences, but also for construing ourselves and our own perspective, and coordinating it with that of others. This is essential for interacting with others and thinking about other minds. From a developmental perspective, coordinating self-other perspective is challenging for children: they have been shown to focus predominantly on their own perspective, a phenomenon coined *egocentrism* (Piaget, 1926). With development, children increasingly master the capacity of coordinating potentially conflicting perspectives, an essential component of Theory of Mind, the attribution of mental states to others and to oneself (Premack & Woodruff, 1978). Before they do so, however, it has been suggested that young infants may not experience a conflict between their own and others' perspective, but instead, may be *altercentric*, that is, rely primarily on the perspective of others (Grosse Wiesmann & Southgate, 2021; Southgate, 2020). While infant altercentricism may provide a basis for perspective taking by being attuned to others (Southgate, 2020), to intentionally align one's perspective with that of others one arguably also has to grasp the distinctiveness of self and other, to then be able to bring about alignment.

How could the ability to understand the self in relation to others develop? In everyday turn-taking interactions there is often alternating reference to the caretaker's and the infant's body (e.g., showing something on one's own face, and then on the infant's). Such interactions – which infants seem to master between 12 and 18 months of age (Carpenter et al., 2005) – may facilitate detecting a correspondence, but also highlight the distinctiveness of self versus others. In contrast with mirrors that provide spatiotemporally reliable, perfectly contingent feedback on one's self, the imperfect contingency of interactions may help to distinguish perceptual input directly linked to the self (e.g., a mirror image, or proprioception) compared to input coming from others (Gergely, 2001; Gergely & Watson, 1999). As such, the imperfect contingencies, combined with self-other mapping may provide a potential pathway to a socially constructed self.

ACKNOWLEDGMENTS

The authors thank the participating families; Helle Lukowski Duplessy, Emilie Poulsen, and Kathrine Habdank with their help in data collection; and two anonymous reviewers for their thoughtful comments on previous versions of the manuscript. The present work was supported by a Consolidator Grant from the ERC (DEVOMIND 726114) to VS and a Marie Skłodowska-Curie Fellowship (ToMSelfLink 799734) to CGW.

Open access funding enabled and organized by Projekt DEAL.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ETHICAL APPROVAL

Ethics approval was obtained from the Ethics Committee of the Department of Psychology at the University of Copenhagen. No materials from other sources have been used.

AUTHOR CONTRIBUTIONS

Conceptualization: Dora Kampis, Charlotte G. Wiesmann, and Victoria Southgate. *Methodology, investigation, and analyses:* Sarah Koop, Charlotte G. Wiesmann, and Dora Kampis. *Writing – original draft:* Charlotte G. Wiesmann, Dora Kampis, and Sarah Koop. *Writing – review & editing:* Victoria Southgate. *Supervision:* Victoria Southgate. *Funding acquisition:* Charlotte G. Wiesmann and Victoria Southgate. *Project administration:* Charlotte G. Wiesmann and Dora Kampis.

DATA AVAILABILITY STATEMENT

All data and materials are available from OSF.

ORCID

Dora Kampis  <https://orcid.org/0000-0003-1678-3874>

REFERENCES

- Agnetta, B., & Rochat, P. (2004). Imitative games by 9-, 14-, and 18-month-old infants. *Infancy*, 6(1), 1–36. https://doi.org/10.1207/s15327078in0601_1
- Amsterdam, B. (1972). Mirror self-image reactions before age two. *Developmental Psychology*, 5(4), 297–305. <https://doi.org/10.1002/dev.420050403>
- Anisfeld, M. (1991). Neonatal imitation. *Developmental Review*, 11(1), 60–97. [https://doi.org/10.1016/0273-2297\(91\)90003-7](https://doi.org/10.1016/0273-2297(91)90003-7)
- Asendorpf, J. B., & Baudonnière, P. M. (1993). Self-awareness and other-awareness: Mirror self-recognition and synchronic imitation among unfamiliar peers. *Developmental Psychology*, 29(1), 88–95. <https://doi.org/10.1037/0012-1649.29.1.88>
- Asendorpf, J. B., Warkentin, V., & Baudonnière, P. M. (1996). Self-awareness and other-awareness. II: Mirror self-recognition, social contingency awareness, and synchronic imitation. *Developmental Psychology*, 32(2), 313–321. <https://doi.org/10.1037/0012-1649.32.2.313>
- Bahrick, L. E. (2013). Body perception: Intersensory origins of self and other perception in newborns. *Current Biology*, 23(23), R1039–R1041. <https://doi.org/10.1016/j.cub.2013.10.060>
- Bates, E. (1990). Language about me and you: Pronominal reference and the emerging concept of self. In D. Cicchetti & M. Beeghly (Eds.), *The self in transition: Infancy to childhood* (pp. 165–182). University of Chicago Press.
- Begus, K., Gliga, T., & Southgate, V. (2016). Infants' preferences for native speakers are associated with an expectation of information. *Proceedings of the National Academy of Sciences*, 113(44), 12397–12402. <https://doi.org/10.1073/pnas.1603261113>
- Brosch, T., Callaghan, T., Henrich, J., Murphy, C., & Rochat, P. (2011). Cultural variations in children's mirror self-recognition. *Journal of Cross-Cultural Psychology*, 42(6), 1018–1029. <https://doi.org/10.1177/0022022110381114>
- Bulgarelli, C., Blasi, A., de Klerk, C. C. J. M., Richards, J. E., Hamilton, A., & Southgate, V. (2019). Fronto-temporoparietal connectivity and self-awareness in 18-month-olds: A resting state fNIRS study. *Developmental Cognitive Neuroscience*, 38, 100676. <https://doi.org/10.1016/j.dcn.2019.100676>
- Carpenter, M., Tomasello, M., & Striano, T. (2005). Role reversal imitation and language in typically developing infants and children with autism. *Infancy*, 8(3), 253–278. https://doi.org/10.1207/s15327078in0803_4



- Duval, S., & Wicklund, R. A. (1972). *A theory of objective self awareness*. Academic Press.
- Filippetti, M. L., Johnson, M. H., Lloyd-fox, S., Dragovic, D., & Farroni, T. (2013). Report body perception in newborns. *Current Biology*, 23(23), 2413–2416. <https://doi.org/10.1016/j.cub.2013.10.017>
- Filippetti, M. L., Longo, M. R., Farroni, T., & Johnson, M. H. (2015a). Neural mechanisms of body awareness in infants. 3779–3787. <https://doi.org/10.1093/cercor/bhu261>
- Filippetti, M. L., Orioli, G., Johnson, M. H., & Farroni, T. (2015b). Newborn body perception: Sensitivity to spatial congruency. *Infancy*, 20(4), 455–465. <https://doi.org/10.1111/inf.12083>
- Gergely, G. (2001). The obscure object of desire: “Nearly, but clearly not, like me”: Contingency preference in normal children versus children with autism. *Bulletin of the Menninger Clinic*, 65(3), 411–426. <https://doi.org/10.1521/bumc.65.3.411.19853>
- Gergely, G., & Watson, J. S. (1999). Early Socio-emotional development: Contingency perception and the social-biofeedback model. In Philippe Rochat, *Early social cognition: Understanding others in the first months of life* (pp. 101–136). Mahwah: Lawrence Erlbaum Associates.
- Grosse Wiesmann, C., & Southgate, V. (2021). Early theory of mind development: Are infants inherently altercentric?. In M. Gilead & K. N. Ochsner (Eds.), *The neural basis of mentalizing* (pp. 49–66). Springer.
- Heyes, C. (2011). Automatic imitation. *Psychological Bulletin*, 137(3), 463–483. <https://doi.org/10.1037/a0022288>
- Howe, M. L., Courage, M. L., & Edison, S. C. (2003). When autobiographical memory begins. *Developmental Review*, 23(4), 471–494. <https://doi.org/10.1016/j.dr.2003.09.001>
- Jones, S. S. (2009). The development of imitation in infancy. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1528), 2325–2335. <https://doi.org/10.1098/rstb.2009.0045>
- Kinzler, K. D., Dupoux, E., & Spelke, E. S. (2007). The native language of social cognition. *Proceedings of the National Academy of Sciences*, 104(30), 12577–12580. <https://doi.org/10.1073/pnas.0705345104>
- Leed, J. E., Chinn, L. K., & Lockman, J. J. (2019). Reaching to the self: The development of infants’ ability to localize targets on the body. *Psychological Science*, 30(7), 1063–1073. <https://doi.org/10.1177/0956797619850168>
- Lewis, M. & Ramsay, D. (2004). Development of self-recognition, personal pronoun use, and pretend play during the 2nd year. *Child Development*, 75(6), 1821–1831. <https://doi.org/10.1111/j.1467-8624.2004.00819.x>
- Mahajan, N., & Wynn, K. (2012). Origins of “us” versus “them”: Prelinguistic infants prefer similar others. *Cognition*, 124(2), 227–233. <https://doi.org/10.1016/j.cognition.2012.05.003>
- Marshall, P. J., & Meltzoff, A. N. (2015). Body maps in the infant brain. *Trends in Cognitive Sciences*, 19(9), 499–505. <https://doi.org/10.1016/j.tics.2015.06.012>
- Mead, G. H. & Morris C. W. (Ed.). (1934). *Mind, self, and society* (18th ed.). The University of Chicago Press. <https://doi.org/10.2307/1415920>
- Moore, C. (2007). Understanding self and others in the second year. In C. A. Brownell & C. B. Kopp (Eds.), *Socioemotional development in the toddler years: Transitions and transformations* (pp. 43–65). Guilford Press.
- Musholt, K. (2012). Self-consciousness and intersubjectivity. *Grazer Philosophische Studien*, 84, 63–89. https://doi.org/10.1163/9789401207904_005
- Piaget, J. (1926). *The language and thought of the children*. Turbner and Co., Ltd.
- Povinelli, D. J. (1995). The unduplicated self. In Phillippe Rochat (Eds.), *The self in infancy: Theory and research* (pp. 161–192). Elsevier.
- Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind?. *Behavioral and Brain Sciences*, 1(4), 515–526. <https://doi.org/10.1017/S0140525X00076512>
- Richter, N., Tiddeman, B., & Haun, D. B. (2016). Social preference in preschoolers: Effects of morphological self-similarity and familiarity. *Plos One*, 11(1), e0145443. <https://doi.org/10.1371/journal.pone.0145443>
- Rochat, P. (2009). *Others in mind: Social origins of self-consciousness*. Cambridge University Press.
- Rochat, P. (2010). The innate sense of the body develops to become a public affair by 2–3 years. *Neuropsychologia*, 48, 738–745. <https://doi.org/10.1016/j.neuropsychologia.2009.11.021>
- Rochat, P. (2013). Self-conceptualizing in development. In Philip David Zelazo, *The Oxford handbook of developmental psychology* (Vol. 2, pp. 378–397). Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780199958474.013.0015>
- Rochat, P., Broesch, T., & Jayne, K. (2012). Social awareness and early self-recognition. *Consciousness and Cognition*, 21(3), 1491–1497. <https://doi.org/10.1016/j.concog.2012.04.007>
- Rochat, P., & Hespos, S. J. (1997). Differential rooting response by neonates: Evidence for an early sense of self. *Infant and Child Development*, 6(3–4), 105–112. [https://doi.org/10.1002/\(sici\)1099-0917\(199709/12\)6:3/4<105::aid-edp150>3.0.co;2-u](https://doi.org/10.1002/(sici)1099-0917(199709/12)6:3/4<105::aid-edp150>3.0.co;2-u)
- Southgate, V. (2020). Are infants altercentric? The other and the self in early social cognition. *Psychological Review*, 127(4), 505–523. <https://doi.org/10.1037/rev0000182>
- Stipek, D. J., Gralinski, J. H., & Kopp, C. B. (1990). Self-concept development in the toddler years. *Developmental Psychology*, 26(6), 972–977. <https://doi.org/10.1037/0012-1649.26.6.972>
- Tajfel, H., & Turner, J. C. (1979) An integrative theory of intergroup conflict. In W.G. Austin & Wercehl (Eds.), (Orgs). *The social psychology of intergroup relations*. Brooks-Cole.
- Want, S. C., & Harris, P. L. (2002). How do children ape? Applying concepts from the study of non-human primates to the developmental study of ‘imitation’ in children. *Developmental Science*, 5(1), 1–14. <https://doi.org/10.1111/1467-7687.00194>
- Zmyj, N., Prinz, W., & Daum, M. M. (2013). The relation between mirror self-image reactions and imitation in 14- and 18-month-old infants. *Infant Behavior and Development*, 36(4), 809–816. <https://doi.org/10.1016/j.infbeh.2013.09.002>

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher’s website.

How to cite this article: Kampis, D., Grosse Wiesmann, C., Koop, S., & Southgate, V. (2021). Understanding the self in relation to others: Infants spontaneously map another’s face to their own at 16 to 26 months. *Developmental Science*, e13197. <https://doi.org/10.1111/desc.13197>