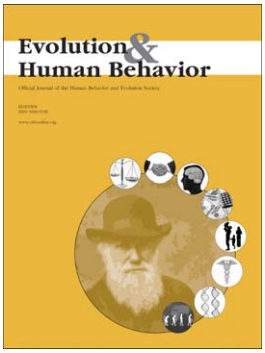

Young children discriminate genuine from fake smiles and expect people displaying genuine smiles to be more prosocial

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Running Head: Genuine smiles and prosociality

Young children discriminate genuine from fake smiles and expect people displaying genuine smiles to be more prosocial

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Abstract

We investigated when young children become sensitive to one evolutionary important signal of honest affiliative and cooperative intent: a genuine (Duchenne) smile. Altogether, we tested 168 children between 2 and 5 years of age in a series of studies aimed at mapping the development of children's ability to discriminate genuine from fake smiles, their preference for genuine smiles, and their understanding of how genuine smiles are linked with prosocial behavior. Studies 1-4 showed that children's ability to discriminate, and answer questions about, the different types of smiles gradually improves between the ages of 2 and 4 years: from implicitly discriminating the smiles in their gaze behavior (at age 3), to being able to identify genuine smiles explicitly in a verbal task (at age 4). Study 5 showed that 4- to 5-year-old children expect people displaying genuine smiles to be more prosocial than those displaying fake smiles. These results demonstrate that the origins of this evolutionarily important form of partner choice appear early in development.

Key words: genuine (Duchenne) smile, facial expression, cooperation, social-cognitive development, prosocial behavior

Young children discriminate genuine from fake smiles and expect people displaying genuine smiles to be more prosocial

1. Introduction

Throughout human evolutionary history, cooperation has played a key role in our survival. Partner choice is critical to the maintenance of cooperation: We must have a means of selecting good cooperators so as to avoid being exploited by cheaters (e.g., Tomasello, Melis, Tennie, Wyman, & Herrmann, 2012; Trivers, 1971). When we have direct experience with a particular individual, or can get reputational information from other sources, it is relatively straightforward to judge whether or not that individual is a good cooperator (Milinski, Semmann, & Krambeck, 2002). However, in the absence of direct experience or reputational information, we need cues that can help us detect honest cooperators – cues which are hard to fake. In an intergroup context, these can include the accent with which someone speaks or other group-specific characteristics signaling in-group membership (Cohen, 2012; Heyes, 2013; Kinzler, Dupoux, & Spelke, 2012). However we also need to be able to detect likely cooperators within intragroup/interpersonal contexts. In this regard, another particularly important cue might be honest positive facial expressions such as genuine smiling (Brown & Moore, 2002; Frank, 1988; Mehu & Dunbar, 2008; Schmidt & Cohn, 2001).

Smiling is an evolved facial display found across human cultures. Some researchers have argued that human smiling could be a homologue to the silent-bare-teeth display found among nonhuman primates (Burrows, Waller, Parr, & Bonar, 2006; Marler & Tenaza, 1977; van Hooff, 1972). The social functions of this display, such as appeasement and reconciliation, have been well discussed in the literature (e.g., de Waal & Luttrell, 1985; Preuschoft & van Hooff, 1997; Waller & Dunbar, 2005). Human infants begin smiling in the womb; however, so-called 'social smiles,' which occur in response to social stimuli, develop

only around age 6 weeks (see Messinger & Fogel, 2007, for a review). Beginning around 8-12 months, infants appear to use smiles communicatively in their social interactions, for example to share attention and interest with their caregivers (Carpenter & Liebal, 2011; Jones & Hong, 2001). Smiling not only functions as an expression of genuine positive emotions but also serves as an affiliative cue to elicit others' positive responses (Owren & Bachorowski, 2001; 2003).

Genuine smiles (Duchenne smiles), which are induced by positive emotions, are particularly valuable as cues in partner choice situations because they cannot easily be faked (Duchenne, 1862/1990; Ekman, Davidson, & Friesen, 1990). According to the Facial Action Coding System (FACS) developed by Ekman and colleagues (1978; 2002), two key muscle areas are involved in a genuine smile, Action Unit 6 (AU6), *orbicularis oculi*, which activates the cheek raiser and causes the crinkling around the eyes, and Action Unit 12 (AU12), *zygomatic major*, which pulls up the corners of the mouth. It has been shown that AU6 cannot be intentionally manipulated by most people (Duchenne, 1862/1990; Ekman et al., 1990). Thus, the genuine smile is an honest signal that reflects sincere positive emotions, and the ability to detect this honest signal can be beneficial in selecting good collaboration partners and avoiding exploitation by dishonest individuals (Brown & Moore, 2002; Frank, 1988).

In support of this idea, a number of studies with adults have found links between genuine smiles and a variety of positive characteristics related to cooperation and prosocial behavior. For example, Mehu, Grammar, and Dunbar (2007) found that pairs of adult participants were more likely to display genuine smiles during a sharing interaction (in which they split 40 euros between themselves) than during a control interaction (in which they discussed pseudonyms). Furthermore, the percentage of their income that participants claimed they would donate to a friend in need specifically predicted the number of genuine

smiles they made during the sharing interaction. In related research, Brown, Palameta, and Moore (2003) had adult participants give a self-introduction, and found that those who were self-reported altruists produced significantly more genuine smiles than those who did not report themselves to be as altruistic (see similar results, also using self-report, in a natural conversation situation; Oda, Yamagata, Yabiku, & Matsumoto-Oda, 2009).

Likewise, in studies investigating our perceptions of smiles, Mehu, Little, and Dunbar (2007) asked adults to rate pictures of faces with different facial expressions. They found that the presence of Duchenne smiles significantly increased participants' ratings of the generosity and extroversion of the people in the pictures. Studies specifically addressing the issue of partner choice showed that adults preferentially choose individuals who display genuine smiles as cooperative partners (e.g., Johnston, Miles, & Macrae, 2010; Krumhuber et al., 2007; Shore & Heerey, 2011) and also find faces with genuine smiles more approachable (Miles, 2009). Finally, Centorrino, Djemai, Hopfensitz, Milinski, and Seabright (2015) found that adult participants were more willing to invest in people displaying genuine smiles in an economic trust game.

Here we investigate the origins of this important cue to partner choice in young children. Young children have been shown to be selective in their choice of whom to cooperate with, help, and trust based on other factors, for example, observations of previous behavior (Dunfield & Kuhlmeier, 2010; Hamlin, Wynn, & Bloom, 2007), the familiarity of the recipients (Olson & Spelke, 2008), and their group membership (Kinzler, Shutts, DeJesus, & Spelke, 2009). However, to date no previous studies have investigated whether young children can use the valuable yet more subtle and fleeting cue of the genuineness of others' smiles in this context.

There is evidence that older, school-aged children can discriminate genuine from fake smiles. Gosselin, Perron, Legault, and Campanella (2002) investigated the specific cues that

adults and school-aged children use to discriminate different types of smiles. They found a significant age effect whereby 6- and 7-year-old children were poorer than adults at distinguishing different types of smiles: 43% of children inaccurately perceived a person with a symmetrical fake smile as 'really happy' whereas only 13% of adults did so (see also Gosselin, Beaupre, & Boissonneault, 2002, for a similar pattern of results). Del Giudice and Colle (2007) investigated how 8-year-olds and adults differ in the cues they use to identify genuine smiles. They showed that 8-year-olds' judgment was positively predicted by the activation of AU6, the Duchenne marker, but also by the activation of AU7, a muscle that can be activated voluntarily to narrow the eyes. In contrast, adults' judgment was positively predicted by the activation of AU6 but negatively predicted by the activation of AU7.

There are also some hints in the literature that young children behave differently in response to an interaction partner producing genuine versus fake smiles. Bugental, Kopeikin, and Lazowski (1991) carried out a study of children's responses to different types of smiles during a short conversation. They videotaped naturalistic conversations between adults and children, and looked at children's gaze behavior immediately after the adults showed a genuine or fake smile. They found that 3- to 6-year-old children were more likely to avert gaze after the adult showed a fake smile. However, it is unclear from this study whether children's gaze behavior resulted from the adults' facial expressions or, equally likely, from the content of the conversation, which was not controlled. In addition, given the small sample size (i.e., just 11 children in the wide age range of 3 to 6 years), it is impossible to know how well the youngest children did this. Convergent evidence from experimental designs and other dependent measures is needed.

It is thus not yet clear at what age children start to be able to discriminate genuine from fake smiles and use genuine smiles as a cue to judging cooperative intent in the context of partner choice. In order to investigate this in a systematic manner, we first used a series of

simple methods to identify the age at which children are first able to discriminate between the different types of smiles (Study 1-4). We then went on to test whether children are able to use genuine smiles as a cue to judging cooperative intent (Study 5).

We chose to focus on preschool-age children because children around this age have been shown to be selective regarding whom they choose to interact with (Kinzler et al., 2010; Kuhlmeier et al., 2014). Furthermore, they are sensitive to subtle differences in other social cues (Brey & Shutts, 2015; Over & Carpenter, 2015), and are able to differentiate real from pretend emotions (Gross & Harris, 1988; Harris et al., 1986; Misailidi, 2006; Mizokawa, 2011). Furthermore, around this age, children are developing an understanding of the psychological states underlying others' behavior – their 'theory of mind' (e.g., Wellman, Cross, & Watson, 2001). It is thus plausible that the ability to identify and make inferences about different types of smiles might develop around the same age.

In pilot work for Studies 1-4, we began by showing 5-year-old children individual pictures of adults who had either a genuine or a fake smile and asking them in which pictures the adult was "really smiling" versus "just pretending to smile." We found that children's performance was at chance level when they were presented with the pictures of smiles in this way, one by one. We then tried presenting 5-year-old children with photographs of two different people at the same time, one with a genuine smile and the other with a fake smile. However, this mode of presentation was distracting in the sense that irrelevant features like hair color and other facial features influenced children's choices. Finally we tried another method of picture presentation: showing children both a genuine and a fake smile of the same person at the same time and asking the same question. Five-year-old children performed at close to ceiling levels on this task. Therefore, in Study 1 we started by using that procedure first with 4-year-olds, and then with 3-year-olds. If children were able to identify genuine

smiles, they should select the photographs of the adults showing a genuine smile when asked to do this.

2 Study 1: Verbal identification of genuine vs. fake smiles in 3- and 4-year-olds

In Study 1, in each of four trials children were presented with two different photographs of the same model simultaneously and were asked to choose the picture in which the model was 'really smiling.' In addition, children were asked to justify why they chose that picture. The justification question was included so that if children succeeded we could see whether they had explicit awareness of what constitutes a genuine smile (and in particular which facial features enabled them to make this judgment).

2.1 Method

2.1.1 **Participants.** Participants were 24 4-year-olds (mean age=51 months, range 48 to 53 months; 12 boys) and 24 3-year-olds (mean age=39 months, range 36 to 41 months; 12 boys). Four additional children were tested but excluded because of experimenter error (*n*=2) or because they failed to provide any responses at all throughout the test session (*n*=2). Children were recruited from and tested in their kindergarten in a middle-sized town in [masked for review]. Although no specific demographic data were collected, participants came from mostly middle-class backgrounds, and approximately 98% of the population from which the sample was drawn is native [masked nationality]. All children had parental permission to participate.

2.1.2 **Design, materials, and counterbalancing.** Children were presented with four sets of two photographs (each measuring 15 x 11 cm) of four different models smiling, one set of pictures at a time. The photographs were a subset of those used in Miles and Johnston's (2007) study of adults, and were used with permission from the first author. The photographs were taken from videotapes of the models' faces. To elicit fake smiles, Miles and Johnston

asked the models to pose a smile (as, for example, for a family picture). Genuine smiles were the models' spontaneous responses to being presented with positive sound clips (e.g., laughs) and pictures (e.g., babies and kittens). Based on those authors' FACS coding, only those people who contracted both the *zygomatic major* (AU12) and the *orbicularis oculi* (AU6) muscles, and who reported a positive mood, were included in the genuine smile set (see Miles & Johnston, 2007, for more details). Again based on their FACS coding, the two smiles in each set were reported to be matched in intensity by Miles and Johnston (2007). In our study, each set of photographs included two pictures of the same model, one with a genuine enjoyment smile and the other with a fake, posed, non-enjoyment smile (see Figure 1). The two smiles for each model were either both closed-mouthed or both open-mouthed. The side that the genuine smile was on was fully counterbalanced. The presentation order of the sets of the pictures was also counterbalanced. Each picture was presented once in each position such that there were twelve unique orders. Children were tested individually and the entire session was video-taped.

2.1.3 **Procedure.** Children sat beside the experimenter (E) at a table in a quiet room in their kindergarten. E said to the children, "I will show you some pictures of smiling people and ask you some questions." E then put the first set of pictures on the table in front of children and said, "Here are two pictures of this woman/man. In one of these pictures, she/he is really smiling and in the other picture, she/he is just pretending to smile. In which picture is she/he really smiling?" Children answered the question by pointing to one of the two pictures. E then asked the justification question, "How do you know?" After children answered this question, E presented the other sets of pictures in the same way and asked the same questions. If children were reluctant to choose a picture, E prompted them by saying, "Show me. In which picture is she/he really smiling?" E went on to the next set of pictures if children still gave no answer after two prompts. If children did not answer the justification

question, given the fact that this question is quite difficult for young children, E went on to the next set of pictures after waiting for approximately five seconds. The instructions were the same for all the picture sets, so it might have seemed overly repetitive and thus unnecessary to some children to hear them four times; in this case, after two picture sets, if children immediately gave answers when seeing the pictures, E did not repeat the instructions again but rather let children answer of their own accord.

2.1.4 **Coding.** For analyses involving children's choice of picture, we used the percentage of trials in which children correctly chose (typically by pointing to it) the genuine smile. All of children's responses were coded live by E, who was not informed of the hypotheses of the study. To assess inter-rater reliability for this measure, 25% of responses at each age were later coded independently from the videotapes by the first author. For both age groups and both measures, agreement between the two coders was perfect (Cohen's kappa =1). For children's justifications, children's answers were transcribed from the videotapes by E and an independent coder. We focused on answers either that referred to the key eye and/or mouth areas (i.e., pointing to or verbally mentioning differences in the eyes or mouth) or that included mention of relevant behaviors and emotions like smiling in a certain way, laughing, or being happy (see below for some examples of what children said). All other answers were counted as unrelated answers, for example, "Because I know it," "Because I see it," "Mm," or "I don't know."

2.2 Results

All reported *p* values in all five studies are two-tailed. In each study, preliminary analyses were conducted to investigate effects of the counterbalancing variables relating to side of presentation (left or right), trial number (1-4), participants' gender (male or female), and the particular face presented. There were no effects of side of presentation or trial number in any of the studies. All preliminary analyses are reported in detail in the

Supplementary Materials. We only mention significant effects in the main text; when no differences are mentioned, the data were collapsed across these variables.

2.2.1 Four-year-olds. In response to the question "In which picture is she/he really smiling?" 4-year-old children were able to choose the genuine smile. They were correct on average in 75% of the trials (*SD*=22%). A one-sample *t*-test compared to the chance level of 50% showed that as a group children were correct significantly more often than chance, $t(23)=5.54$, $p<.001$, $d=1.13$. Out of all children, 70.8% of them ($n=17$) answered correctly in more than half of the trials; 25.0% of them ($n=6$) did so in half of the trials, and 4.2% of them ($n=1$) did so in fewer than half of the trials.

A Cochran's *Q* test showed an effect of face set on 4-year-old children's performance, $Q(3)=8.89$, $p=.030$, $r_{equivalent}=.55$ (Rosenthal & Rubin, 2003). Post-hoc analyses using McNemar tests indicated that performance on face D (see Figure 1) was significantly poorer than performance on face A, $\chi^2(1)=4.08$, $p = .043$, $\Phi_{Cramer}= .41$. Performance did not differ between any of the other sets of faces. See Table S1 in the Supplementary Materials for children's performance on each set of faces individually.

Turning to children's justifications, although 83.3% of children ($n=20$) gave an answer to at least some of the questions, only 29.3% of children ($n=7$) gave at least one relevant answer. None of them specifically mentioned the eye area. Two children focused on the appearance of the mouth (e.g., saying, "Because she's grinning like this" or "Because here she is opening her mouth really wide," pointing to the mouth in the picture). Three children mentioned laughing (e.g., "Because she is laughing," Because he can laugh better"). And two children referred to the positive emotion expressed by the person in the picture (e.g., "Because she looks so happy here").

2.2.2 Three-year-olds. As a group, 3-year-old children were not able to identify the genuine smile in this test. They were correct on average in 51% of the trials (*SD*=27%), one-

sample *t*-test, $t(23)=0.25$, $p=.80$, $d=.05$. Out of all children, only 29.2% of them ($n=7$) answered correctly in more than half of the trials; 50% of them ($n=12$) did so in half of the trials, and 20.8% of them ($n=5$) did so in fewer than half of the trials.

Turning to children's justifications, 66.7% of children ($n=16$) gave a verbal or gestural response (e.g., shrugging their shoulders) to at least some of the questions. However, only 8.3% of the children ($n=2$) said anything relevant. Both mentioned laughing (e.g., "Well, because she is laughing there").

2.2.3 Age comparison. As a group, 4-year-old children performed significantly better than did 3-year-old children, $t(46)=3.33$, $p=.002$, $d=0.96$, thus demonstrating that the ability to identify genuine smiles in this test develops between the ages of three and four.

2.3 Discussion

Study 1 investigated whether 3- and 4-year-old children are able to identify genuine (vs. fake) smiles, and whether they are able to justify their choice. We found that 4- but not 3-year-olds can make this type of explicit judgment quite well: The 4-year-olds were able to identify the genuine smile significantly more often than chance. When it came to justifying their choice, only a minority of children at both ages were able to give relevant answers. All of these answers involved either the way the mouth area looked, laughing, or the general positive emotional expression of the face. It is unclear whether the other children were not consciously aware of the relevant differences in the faces or whether they did notice them but were unable to communicate about them to E.

There are several possible explanations for why 3-year-olds did not choose the genuine smiles in this particular task. First, it is possible that children this young are simply unable even to discriminate genuine from fake smiles − perhaps they see both types as just 'smiles.' However, a plausible second possibility is that they can discriminate them but the questions we asked were just too difficult for them. Informally, we noticed that the 4-year-

olds usually only needed to hear the instructions and questions for the first two picture sets and then they were able to answer immediately with the further sets without hearing the questions again. In contrast, the 3-year-olds usually needed E to repeat the instructions for each picture set, sometimes even twice for each set, indicating that they might not have fully understand what she was asking. Compared to the 4-year-olds, they were also more likely to talk about unrelated matters to E throughout the test session, perhaps indicating a low level of engagement with the task.

Thus, in the next study, we used a procedure with fewer task demands to further investigate whether 3-year-olds see a difference between the two types of smiles. In this study, rather than asking children to identify the real smile, inspired by research with adults which asked about participants' preferences for genuine smilers (see Shore & Heerey, 2011), we showed children the same pictures and simply asked them which picture of the person they liked better. We reasoned that, if 3-year-old children can see a difference between genuine and fake smiles, then they might show a preference for one of the smiles – presumably the genuine smile; otherwise, if they could see no difference between them, they should respond at chance levels.

3 Study 2: Verbal preference test with 3-year-olds

In Study 2, 3-year-old children were presented with the same sets of photographs as in Study 1 and were simply asked to choose which pictures they liked better.

3.1 Method

3.1.1 **Participants.** Participants were a new set of 24 3-year-olds (mean age = 39 months, range 36 to 41 months; 12 boys) who were recruited and tested in the same way as in Study 1. Three additional children were tested but excluded because they failed to provide any responses at all throughout the test session.

3.1.2 **Design and Materials.** The design, materials, and counterbalancing were exactly the same as in Study 1.

3.1.3 **Procedure.** The procedure was identical to that of Study 1 in all but the questions asked. In this study, children were asked, "Here are two pictures of this lady/man. Which picture of her/him do you like better?" Children were not asked to explain their choices because Study 1 had already shown that they were generally unable to give relevant justifications.

3.1.4 **Coding.** Children's choices were coded from the videotapes by the first author. To assess inter-rater reliability, a second coder who was not informed of the hypothesis of the study independently coded 25% of responses. Agreement between the two coders was perfect (Cohen's kappa=1).

3.2 Results

As a group, 3-year-old children did not consistently prefer either type of smile picture. They chose the genuine smile on average in 48% of the trials (*SD*=21%), one-sample *t*-test, $t(23)=-0.49$, $p=.63$, $d=-0.10$. Out of all children, only 16.7% of them ($n=4$) preferred the genuine smile photographs in more than half of the trials; 58.3% of them ($n=14$) did not express any systematic preference – they selected genuine and fake smile photographs an equal number of times; and 25% of them ($n=6$) preferred the fake smile photographs in more than half of the trials.

3.3 Discussion

Study 2 investigated whether 3-year-old children say that they prefer genuine over fake smiles when explicitly asked about their preference. We found that, as a group, 3-year-olds expressed no reliable verbal preference. Even within individual children there was rarely a systematic preference (i.e., it was not the case that half the children reliably preferred genuine and half reliably preferred fake smiles). Informally, we noticed that, unlike the

children in Study 1, the 3-year-olds in this study were quite focused on the task: They listened to the instructions attentively, made their choices immediately, and did not talk about irrelevant things. Thus it seemed that the instructions and procedure were probably appropriate for 3-year-olds.

Again, there are a number of possible reasons why 3-year-olds might have failed at this task. It is possible that 3-year-olds simply do not see the difference between genuine and fake smiles or that they do see a difference but do not have a preference for one or the other. However, it is also possible that they do see the difference, but that, again, something about the procedure of the study prevented them from showing it. In the current Studies 1 and 2, children were asked to respond to verbal questions by pointing. This type of task requires them to comprehend the verbal instructions and questions and, in addition, requires some level of coordinated behavior, working memory, and executive function (Baillargeon et al., 2010; Hood, Cole-Davies, & Dias, 2003). Thus it would also be informative to use a more spontaneous and even more implicit measure to further investigate children's discrimination and preference. Many studies use implicit measures, such as looking time, to investigate young children's understanding across a variety of domains of both physical and social cognition. These studies suggest that implicit understanding might precede explicit knowledge (e.g., in studies of false belief: Baillargeon, Scott, & He, 2010; Clements & Perner, 1994; and invisible displacement of objects: Baillargeon, Spelke, & Wasserman, 1985; Hood et al., 2003).

We thus used eye tracking in a final attempt to test 3-year-olds. Eye tracking allows children to scan pictures freely. It does not require understanding of instructions or verbal abilities to complete the task. Most importantly, it allows us to explore children's spontaneous reactions to the different smiles, as opposed to their explicit judgments about them.

We hypothesized that if 3-year-old children are able to discriminate between the different types of smiles, this should be reflected in their gaze behavior; in particular, they should look longer to one type of smile than the other. Furthermore, a difference in looking time might also reflect a preference; if children prefer genuine smiles, then they ought to look significantly longer at them than at the fake smiles.

4 Study 3: Eye-tracking test with 3-year-olds

In Study 3, we investigated whether 3-year-old children look longer at genuine vs. fake smiles using an eye-tracking paradigm. Three-year-olds watched as the same pairs of smile photographs from Studies 1 and 2 were presented on a computer monitor and their looking toward the different faces was recorded.

4.1 Method

4.1.1 **Participants.** Participants were a new set of 24 3-year-olds (mean age = 40 months, range 38 to 41 months; 12 boys). Four additional children were tested but excluded due to inattentiveness (*n*=2) and experimenter error (*n*=2). Children's parents were invited by telephone and children were tested in a lab specially designed for studies with children. All children had parental permission to participate.

4.1.2 **Design and Materials.** Children were presented with the same four sets of photographs as in Studies 1 and 2, however the background of the photographs was light grey in this study instead of white for better viewing in a dimmed-light room. Each picture set was presented for 10 seconds. Between the presentation of each set of pictures, a plus sign was presented in the center of a light grey screen for 1.5 seconds in order to attract children's attention to the middle of the screen before each trial. The pictures were presented at a resolution of 1400 x 1050 pixels on a 24" (52cm x 32cm) computer screen and each face was approximately 529 x 680 pixels. Children's gaze was tracked using a Tobii eye tracker,

model X120, with a sampling frequency of 60Hz. The eye tracker records the X and Y coordinates of children's eye position and the average value of both eyes was used to estimate the single gaze point. The test session was presented as shown in Figure 2a. The side that the genuine smile was on and the order of the picture sets were fully counterbalanced (with the same 12 orders in total).

4.1.3 **Procedure.** During the test, children sat approximately 65cm away from the computer screen in a dimly lit room. E adjusted the screen until the eye tracker cameras detected children's corneal reflection. During this process, so that children would keep watching the screen until their corneal reflections were detected, a video of a fish tank with moving fish was shown on the screen. E then said to the children, "I will show you some pictures. First, there will be a duck, please watch where it goes. And then I will show you some pictures of smiling people." E then sat behind the child (about a half meter from the child) and pretended to write something. The duck was presented sequentially at different locations on the screen in a 5-point calibration sequence. Calibration accuracy was checked and repeated if it was unsuccessful.

The test started immediately after calibration. Children scanned the pictures freely. If children attempted to talk to E, E continued writing and just said, "Look." The entire test session lasted about one minute. After the test session, a short cartoon video was shown (this was done simply to make the test experience more fun for children).

4.1.4 **Analyses.** An I-VT filter (classifier 30°/s; window length: 20ms) provided by the Tobii software was applied to all raw eye-tracking data. Under this filter, a fixation was defined as a period of looking within a radius of 50 pixels for at least 40 ms.

Each face was divided into three areas of interest (AOIs). Of most interest was the face AOI, which encompassed the entire face from the top of the hairline to the bottom of the chin and from the furthest point of the left ear to the furthest point of the right ear,

approximately 529 x 680 pixels, 12 x 16 degrees at 65cm viewing distance. We were also interested in whether children looked to the general areas that are useful in determining whether a smile is genuine or fake. Thus the eye AOI encompassed both eyes from the top of the eyebrow to the top of the cheekbone and from the left edge to the right edge of the face, approximately 426 x 113 pixels, 10 x 3 degrees at 65cm viewing distance. The mouth AOI encompassed the mouth area from the bottom of the nose to the middle of the chin and from the left edge to the right edge of the face, approximately 340 x 151 pixels, 8 x 4 degrees at 65cm viewing distance. Thus for each picture set (i.e., pair of faces), there were two face AOIs, two eye AOIs, and two mouth AOIs across the two faces (see Figure 2c for an example). All AOIs were exactly the same size for the two faces of the model in any given picture set.

We analyzed total fixation duration. Total fixation duration was calculated as the sum of the duration of all fixations children made within an AOI (and it is therefore equivalent to looking time). The percentage of time children spent looking at each AOI using this measure was then calculated and used for analyses. For the face AOI this was calculated as a percentage of the total fixation duration to the two face AOIs; for the eye and mouth AOIs this was calculated as a percentage of the total fixation duration to the corresponding face AOI.

4.2 Results

Table 1 presents the mean and percentage of total fixation durations for each AOI. As a group, 3-year-old children looked at the faces with genuine smiles significantly longer than at the faces with fake smiles. A one-sample *t*-test revealed that the percentage of fixation duration at the faces with genuine smiles was significantly greater than the chance level of 50%, $t(23)=2.23$, $p=.036$, $d=.49$. On the individual level, 75% of children ($n=18$) spent a greater percentage of time looking at the faces with genuine smiles than at the faces with fake

smiles, and 25% of them (n=6) did the opposite. A chi-square test revealed that significantly more children looked longer at the faces with genuine smiles than looked longer at the faces with fake smiles, $\chi^2(1)=6.00$, p=.014, odds ratio=3. Children looked at both the eye and mouth AOIs within the genuine smile pictures for a similar amount of time as they looked at the eye and mouth AOIs within the fake smile pictures (paired-sample t-tests; for eye AOIs: $t(23)=-0.64$, p=.53, d=-.13; for mouth AOIs: $t(23)=0.28$, p=.79, d=.06).

For exploratory purposes, we also checked the number of looks children made toward each AOI. Fixation count was calculated as the number of fixation points children made within an AOI. For these analyses, the significance of all p values mirrored the results presented above for fixation duration.

4.3 Discussion

Study 3 used eye tracking to investigate whether 3-year-old children look more at genuine smiles than fake smiles. We found that in this test they were able to discriminate the two types of smiles. As a group, children looked both longer and more often than chance at the faces with genuine smiles. At an individual level, too, significantly more children looked longer and more often at the faces with genuine smiles than did so at the faces with fake smiles. Thus, although 3-year-old children were not able to provide explicit verbal judgments about the genuineness of smiles (either in terms of identifying them or preferring them), in a more implicit, eye-tracking test they were able to discriminate between them, looking more at the genuine smile. Whether this small but significant difference in looking time reflected an understanding that one smile was genuine and one was fake, and whether it reflected a real preference for the genuine smiles, is unclear. Looking-time differences can be driven by a number of things, for example novelty, violation of expectation, or preference (Oakes, 2010). Since it is extremely unlikely that either genuine smiles or fake smiles are novel or surprising to 3-year-old children – both types occur frequently in everyday life – it is plausible that the

longer looking to genuine smiles does reflect a preference. However, this is something that needs to be investigated further in future research.

With regard to the key areas of the faces that distinguish the two types of smiles, 3-year-olds did not look at the eye and mouth AOIs within genuine smile pictures longer, or more often, than they looked at these AOIs within fake smile pictures. At first glance, this result might seem puzzling; however, it is important to note that similar results have been obtained with adults (Manera, Del Giudice, Grandi, & Colle, 2011; Perron & Roy-Charland, 2013). Perron and Roy-Charland (2013) suggest that this is because processing of the eye area is done very quickly and thus long looking toward the eyes is unnecessary.

Given 3-year-olds' ability to discriminate the two types of smiles, in the next study we tested whether even younger children, 2-year-olds, could do this as well.

5 Study 4: Eye-tracking test with 2-year-olds

In Study 4, we used the same smile stimuli as in Study 3. However, in order to make the procedure more age appropriate for the younger children, we had to modify the eye-tracking procedure somewhat.

5.1 Method

5.1.1 **Participants.** Participants were 24 2-year-olds (mean age = 28 months, range 24 to 30 months; 12 boys). Three additional children were tested but excluded due to inattentiveness (n=2) and experimenter error (n=1). Children were recruited and tested as in Study 3.

5.1.2 **Design, Materials, Procedure, and Data Analysis.** The design, materials, counterbalancing, procedure, and data analysis were generally the same as in Study 3, with the following exceptions. First, when piloting with 2-year-old children, we noticed that children sometimes lost interest in the middle of a trial and did not look back to the screen

even after the following trial started. In order to make sure that children were looking when the trial started, we replaced the plus sign which was presented between trials with a still picture of a toy accompanied by a rattle sound. In this case, even if children were distracted in the middle of a trial, their attention would be caught back by the toy presentation. Second, we made the start of the trial contingent upon children's gaze to the screen: As soon as children fixated their gaze on the toy, we immediately continued with the next set of smile pictures. If children did not focus back on the screen after the toy picture had been shown for the maximum amount of time (4000 ms), we continued with the next set of pictures; this happened in only one trial for one child. The session was presented as shown in Figure 2b.

5.2 Results

Table 1 presents the mean and percentage of fixation duration for each AOI. As a group, 2-year-old children looked at the faces with genuine smiles for about the same length of time as they looked at the faces with fake smiles. A one-sample *t*-test revealed that, although there was a trend in the same direction as with the 3-year-olds, the percentage of fixation duration at the faces with genuine smiles was not significantly different from the chance level of 50%, $t(23)=1.79$, $p=.087$, $d=.36$. On the individual level, 58.3% of children ($n=14$) spent a greater percentage of time looking at the faces with genuine smiles than at the faces with fake smiles; 41.7% of them ($n=10$) did the opposite. A chi-square test showed that the number of children who looked longer at the faces with genuine smiles was not statistically different from the number of children who looked longer at the faces with fake smiles, $\chi^2(1)=0.67$, $p=.41$, odds ratio=1.4. Again, children looked at both the eye and mouth AOIs within the genuine smile pictures for a similar amount of time as they looked at the eye and mouth AOIs within the fake smile pictures (paired-sample *t*-tests; for eye AOIs: $t(23)=-0.27$, $p=.79$, $d=.06$; for mouth AOIs: $t(23)=0.59$, $p=.56$, $d=.12$).

We also checked the number of looks children made toward each AOI. Again, for these analyses, the significance of all *p*-values mirrored the results presented above for fixation duration.

5.3 Discussion

Study 4 used eye tracking to investigate whether 2-year-old children look more at genuine than fake smiles. Although their results were not statistically significant, 2-year-olds showed a trend in the same direction as the 3-year-olds. It is thus possible that children at this age are just beginning to be able to discriminate the two types of smiles. It is also possible that the failure to find a significant difference at this age is due to low power, given that any effect would presumably be smaller in this age group. Future research should investigate whether there might be procedural modifications that could improve 2-year-olds' performance (e.g., using videos of smiling people rather than photographs, or changing the duration of stimulus presentation).

6 Study 5: Genuine smiles and expectations of prosociality in 4- and 5-year-olds

Studies 1 through 4 showed that children are able to identify genuine smiles explicitly from the age of four and to discriminate between genuine and fake smiles implicitly by the age of three. Although this identification and discrimination is important, it is key, from both an evolutionary and a developmental perspective, to be able to act upon this knowledge. Thus our next step was to investigate whether young children understand that genuine smiles can convey information about cooperative intent and prosociality within a partner choice context. We showed children photographs of individuals displaying genuine versus fake smiles and asked them to select the nicer person whom they thought would share more resources with them. If children understood the relation between genuine smiles and prosociality, then they should more often choose the person with the genuine smile in this partner choice context.

We tested 4- to 5-year-old children in this study. We chose this age range primarily because this task is more demanding than the tasks used in Studies 1-4. That is, the instructions were more cognitively taxing and, in addition, children needed to make a relatively complex social inference above and beyond their discrimination or identification of the two types of smiles. Thus, 4-year-olds, as the youngest age group who succeeded at the verbal identification tests reported above, served as the youngest participants in this study. We included 5-year-olds as well for the following reason. In this study, we also wished to investigate one possible underlying mechanism that might help predict individual differences among children in the development of this ability, namely children's developing understanding of the psychological states underlying others' behavior – their 'theory of mind.' That is, a main function of fake smiles is to create a false belief in the recipient about the signaler's true emotional state or intentions (Krebs & Dawkins, 1984; Maynard Smith & Harper, 1995; Mehu et al., 2007). Thus an understanding of false beliefs could help children make inferences about whether or not a social partner is trying to deceive them, that is, it could help them become aware that others may want to instill false beliefs in them (Sperber et al., 2010). Indeed, studies have shown that false belief understanding is linked to the development of epistemic vigilance and selective trust in partner choice situations more generally in children (DiYanni, Nini, Rheel, & Livelli, 2012; Vanderbilt, Liu, & Heyman, 2011). It is therefore reasonable to hypothesize that children's understanding of genuine and fake smiles and the types of people who produce them may be associated with their understanding of others' mental states. As performance on standard tests of false-belief understanding undergoes a marked transition around the age of four to five years (e.g., Wellman, Cross, & Watson, 2001), we measured whether children's performance on one such test, the Sally-Anne test (Baron-Cohen, Leslie, & Frith, 1985), predicted children's ability to infer cooperative intent from genuine smiles.

We used the same photographs as stimuli as in the previous studies, for ease of comparison with the previous results. As mentioned above, piloting had shown that presenting children with photographs of two different people was distracting to them. However, in the context of partner choice, which is the main focus of the current study, it was desirable to have children choose between two different people, rather than between two photographs of the same person. In order to work within these constraints, we told children that these photographs were pictures of two different people who were twins and asked them to choose which one of the two they expected to be nicer and more generous (for the use of a similar approach see Dawel, Palermo, Kearney, & McKone, 2015).

6.1 Method

6.1.1 Participants. Participants were a new set of 48 4- to 5-year-old children (mean age = 58 months, range 48 to 66 months; 24 boys). Three additional children were tested but excluded due to their difficulty with the local language (n=2) or inattentiveness throughout the whole session (n=1). Children were recruited in the same manner as in Studies 1 and 2 and were tested in their kindergartens. Six children failed at least one of the control questions in the theory of mind test and were thus included only in the analyses for the smiles test.

6.1.2 **Design, materials and counterbalancing.** For the test, children were presented with the same four sets of photographs as in Studies 1-4. Before that, to introduce the task, children were presented with another pair of photographs of another person from Miles and Johnston's (2007) stimulus set. They were also presented with two line drawings depicting sharing behavior. These drawings were printed on each side of an A4-size piece of paper. On one side, two stick people were shown holding stickers. On the other side, one of the people was shown holding out stickers to share. The materials for the Sally-Anne test were two female dolls (15cm tall), one toy basket, one toy box, and one marble.

6.1.3 **Procedure.** Children sat beside E at a table in a quiet room in their kindergarten. E first explained the concept of twins – people who look alike – by saying, "Today I'm going to show you some photos of twins. Do you know what twins are? They are two people who look exactly the same. Look [placing the sample photographs on the table], here are twins. They look exactly the same. But you know what? They do not always behave the same. Sometimes one is nicer than the other." E then took away the sample picture and put down the picture depicting the figures holding stickers and said, "Here is another picture of twins. Look, they both have stickers. You know what? The nicer one of the two will give you stickers." E then showed the picture on the other side and said, "Look [pointing], one is giving stickers, but the other one is keeping them all for himself." E then took away the drawings and said, "All of the twins that you are about to see also have stickers. In each pair, one of the twins is nicer than the other. Here is the first twin pair. I want you to look at the photos very carefully. Look carefully, how nice they look. One of them is nicer than the other. And the nicer one of them will give you stickers. Show me which one of the two will give you stickers." Children answered the question by pointing to one of the two pictures. E then presented the other sets of pictures in the same way and asked the same questions. If children were reluctant to choose a picture, E prompted them by saying, "Show me. Which one of them will give you stickers?" E went on to the next set of pictures if children still gave no answer after two prompts.

After the smiles test was complete, E administered the Sally-Anne test following the standard procedure (Baron-Cohen et al., 1985). That is, after a false belief was created in one doll regarding the marble's whereabouts, first, the test question, "Where will Sally look for her marble?" was asked, followed by two control questions: "Where is the marble really?" and "Where was the marble at the beginning of the story?"

6.1.4 **Coding.** A coder who was unaware of the hypotheses of the study coded which person children pointed to in the smiles test, and children's answers to the test and control questions in the Sally-Anne test. For analyses for the smiles test, we used the percentage of trials in which children correctly chose the person with the genuine smile. To pass the theory of mind test children needed to answer the test question and all three control questions correctly. To assess inter-rater reliability, 25% of responses were later coded independently from the videotapes by the first author. For both age groups and both tests, agreement between the two coders was perfect (Cohen's kappa =1).

6.2 Results

As a group, 4- to 5-year-old children expected the people displaying genuine smiles to be nicer and more likely to share stickers with them. They were correct on average in 62.2% of the trials (*SD*=25.6%). A one-sample *t*-test compared to the chance level of 50% showed that children were correct significantly more often than chance $t(47)=3.30$, $p=.002$, $d=.48$. Across both ages, 50% of the children ($n=24$) chose the people with genuine smiles as those who would share more in more than half of the trials; 35.4% of them ($n=17$) did so in half of the trials, and 14.6% of them ($n=7$) did so in fewer than half of the trials.

In order to investigate what predicts this ability, we entered three variables into a hierarchical regression model: gender, age, and performance on the theory of mind test. In order to provide a more fine-grained analysis of developmental change, age was treated as a continuous variable and centered in the model. Overall, 31% of children passed the theory of mind test ($n=13$; 6 boys). The age of children who passed this test ($M=58.6$, $SD=5.2$) was not different from that of the children who failed ($M=58.4$, $SD=5.9$), $t(40)=2.02$, $p=.93$, $d=.03$. For the categorical variables, we coded 0=boys and 1=girls, and 0=fail and 1=pass the theory of mind test. We also included gender x age and performance on the theory of mind test x age

as interaction terms. Regression coefficients with 95% confidence intervals, standard errors, beta values, and adjusted R squared changes can be found in Table 2.

Significant regression equations were found in all steps: in step 1, $F(1, 40)=8.85$, $p=.005$; in step 2, $F(2, 39)=10.27$, $p<.001$; in step 3, $F(3, 38)=6.79$, $p=.001$; in step 4, $F(4, 37)=5.29$, $p=.002$; and in step 5, $F(2, 36)=4.12$, $p=.005$. Gender was a significant predictor: girls (M=72.9%, SD=20.7%) were more likely to choose the people with genuine smiles than were boys (M=51.4%, SD=25.7%), $t(40)=2.98$, $p=.005$, $d=.92$ (see Table S2 in the Supplementary Materials for children's performance on each face by gender). With increasing age, children were more likely to choose the people with genuine smiles, $t(39)=-3.12$, $p=.003$, $d=.45$. As is clear from Figure 3, the youngest children responded at near-chance levels. Children's performance on the theory of mind test did not predict their performance on the smiles test (for children who passed the theory of mind test, M=61.5%, SD=28.2%; for children who failed the theory of mind test, M=64.9%, SD=25.0%), $t(38)=-0.48$, $p=.64$, $d=-.13$.)

6.3 Discussion

Along with being able to identify genuine vs. fake smiles (see Study 1), 4- to 5-year-old children are also able to attach social meaning to genuine smiles: They expect people who display genuine smiles to be nicer and more likely to share stickers with them. They thus show some understanding of the link between genuine smiles and prosociality, and they can use these subtle social signals to make appropriate inferences about potential interaction partners.

The expectation that people with genuine smiles would be more prosocial was seen most clearly in the older children and in the girls. Previous research in other areas has shown that girls are more able to use subtle social cues to make inferences about others' behavior (e.g., Brey & Shutts, 2015; Hall, 1978). Consistent with this idea, in the current study, girls

outperformed boys in the test involving the social meaning of the smiles but not in the more basic, cognitive discrimination tasks in Studies 1-4. However, it is also possible that girls performed better because there are more female faces than male faces in the stimuli we used. It is interesting to note in this regard that the boys tended to perform better on the male face than on any of the female ones (see Table S2 in the Supplementary Materials). Future research should further investigate potential gender differences in this ability.

Our aim in this study was to capture the general characteristic of prosociality, which includes niceness and generosity, as well as helpfulness, kindness, cooperativeness, etc. We cannot distinguish in this study which of the two specific prosocial attributes we mentioned, niceness and/or generosity, children associated with genuine smiles. Without a control condition investigating other positive traits, we also do not know whether children would in addition have attributed further positive traits to the people with genuine smiles. That is, it is possible that genuine smiles produce a halo effect of generally positive attributions in young children − although note that this is not the case with adults. Mehu, Little, and Dunbar (2007) found that the type of smile displayed had an effect only on adults' ratings of generosity and extroversion, but not on their ratings of other positive attributes such as attractiveness, agreeableness, openness to experience, conscientiousness, and health. It is an interesting question for future research to investigate precisely which prosocial (and other positive) attributes young children link to genuine smiles.

Children's performance on the theory of mind test did not predict their performance on the smiles test in this study. This could be due in part to low power, as there was only one trial in the false belief test and only 31% of the children passed this test. In future research, it could be interesting to use a theory of mind scale rather than a single trial false belief test (Wellman & Liu, 2004), and to also include other tests of children's understanding of others' real and apparent emotions and deceptive intentions. However, it is also possible that

understanding the connection between real smiles and prosociality develops independently from children's understanding of deception and theory of mind. For example, children may learn that real smiles predict prosociality through repeated exposure to the two types of behavior without initially understanding anything about the intentions behind the different types of smile. Regardless of the mechanism underlying this social inference, however, it is clear from this study that children are able to use their understanding of different types of smiles within the context of partner choice and cooperation.

7 General Discussion

Partner choice is essential for the maintenance of human cooperation (e.g., Tomasello et al., 2012; Trivers, 1971). As a result, humans have evolved signals for displaying cooperative intent, on the one hand, and cognitive mechanisms for identifying and understanding such signals, on the other (Frank, 1998; Krebs & Dawkins, 1984; Maynard Smith & Harper, 1995). One such signal is smiling. Smiling is an evolved behavior which may have its origins in the bared-teeth display of non-human primates (Burrows et al., 2006; Marler & Tenaza, 1977; van Hooff, 1972), and which can convey a variety of positive emotions and intentions. Humans have learned to exploit this behavior in order to signal positive emotions and intentions at will. However, there are subtle differences between genuine, honest smiles and fake, posed smiles that adults, at least, can discern and use in partner choice contexts (e.g., Johnston et al., 2010; Krumhuber et al., 2007; Shore & Heerey, 2011). Here we demonstrate that, when tested with simple methods, even very young children can discriminate between genuine and fake smiles and use them as social cues to evaluate others' cooperative potential. This ability can help children make appropriate choices when deciding with whom to interact and cooperate.

In Study 1, we found that, when presented with two photographs side-by-side and asked in which one the person was "really smiling," 4-year-old, but not 3-year-old, children were able to choose the correct photograph at above-chance levels. In Study 2, 3-year-olds also performed at chance levels on a more implicit version of the same task in which they were simply asked which photograph they preferred. Although 3-year-olds did not perform well on either verbal task, they did show differential gaze behavior in Study 3: They looked at the faces with genuine smiles significantly longer and more often than they did at the faces with fake smiles. In Study 4, 2-year-old children showed a similar pattern of gaze results but the differences did not reach significance. Thus, at least from the age of three and more clearly from the age of four, children are able to discriminate between genuine and fake smiles. In a final study, we investigated directly whether children understand that the genuineness of others' smiles can convey information about their cooperative or altruistic intent. In Study 5, when asked which one of two people was nicer and would share stickers with them, 4- to 5-year-old children chose the person who displayed a genuine smile significantly more often than chance. Study 5 thus demonstrated that between 4 and 5 years of age, children begin to attach social meaning to different smiles and use genuine smiles as a cue to predict prosociality.

The young age of our participants placed some constraints on the methods we could use. In the first, verbal discrimination test, children were only able to succeed when the genuine and fake smile pictures were presented side-by-side rather than serially. In the real world, children would typically see different people displaying different types of smiles, either at the same time or serially. However, showing children different people at different times would add memory demands (as children would have to remember different presentations) and noise to children's judgments (as children would be asked to judge individuals who vary on multiple dimensions). Here we were interested in the earliest age at

which children could make these discriminations and choices, thus we used the simplest methods possible. That is, although other methods might be more naturalistic, they might obscure the earliest manifestations of this ability. Nevertheless, an important caveat to this work is that these results show only the first step in understanding. Clearly, further developments are needed in children's ability to discriminate genuine from fake smiles after the age of five years in order to reach adult competence and the ability to make decisions in more noisy environments.

Still, here we show that a basic ability to identify and use the genuineness of others' smiles in partner choice contexts emerges at precisely the age at which being exploited by cheaters starts to become a serious possibility. Sperber and colleagues (2010) reviewed research from a variety of areas, including children's understanding of deception, dishonesty, reliability, and morality, their selective trust, and their theory of mind. They concluded that, taken together, this research suggests a general developmental transition in children's vigilance toward non-cooperators and deceivers that parallels closely the developmental transition between 2 to 5 years observed in the current studies. Mascaro and Sperber (2009) suggest that this transition may take place when it does because it is around this age that children start becoming more independent and thus begin to encounter both peers and adults who, unlike their protective parents and other close caregivers, may not always be looking out for their best interests.

A remaining question from the current work relates to which specific facial cues children use to discriminate genuine from fake smiles. According to Del Giudice and Colle (2007), 8-year-old children's judgment of genuine smiles was influenced by the activation of AU6 as well as AU7, a muscle that can be activated voluntarily to narrow the eyes. In the stimuli used in the current study, the activation of AU7 was not controlled; thus it is possible that these young children use general eye-narrowing as a cue rather than the specific AU6

activation (resulting in eye crinkling and cheek raising). In addition, the intensity of AU12 (which pulls up the corners of the mouth) is worth discussing. Although Miles and Johnston (2007) stated that their stimuli were matched for intensity, in some of the photographs a slight difference in the intensity of AU12 is still visible. However, when looking at children's responses to each of the faces individually (see the Supplemental Materials), it is evident that there was not great consistency across studies in which faces elicited the best performance. Thus it was unlikely that children were using only the intensity level of AU12 to make their judgments. Still, it will be important for future research to investigate exactly which cues preschoolers use to discriminate genuine from fake smiles.

In future research, it would also be interesting to investigate when in development children first begin to produce fake smiles themselves, and in what contexts. Fake smiles are almost always deceptive but they are not always produced with malicious intent. Sometimes, for example, they are produced in order to spare others' feelings or to be polite. Little is known about children's production of fake smiles to deceive others maliciously by disguising their intention to cheat. However there is one context in particular in which young children (again girls especially) have been observed to produce unfelt polite smiles. Cole (1986) found that upon receiving a disappointing gift, 3- and 4-year-old girls will still smile (see also Cole, Zahn-Waxler, & Smith, 1994). They do this more when the gift giver is present than absent, suggesting that they do it to maintain a positive relationship with the gift giver. In a related study, Talwar, Murphy, and Lee (2007) found that, with increasing age, children were more likely to tell a white lie to disguise their disappointment with an inadequate gift and that they were more likely to smile as they told this white lie as well. Children's ability to use social acting to maintain positivity in social relationships – something which is also beginning to develop during this same age range and which likely also evolved for the maintenance of

cooperation in social groups (Baillargeon et al., 2013) – is an interesting area for future research.

The current work adds important information to research on young children's selectiveness in partner choice. Previous studies have shown that infants and young children behave selectively towards others based on previous experience (e.g., Hamlin et al., 2007; Vaish et al., 2010), group membership (e.g., Dunham, Baron, & Carey, 2011), and familiarity (Kinzler et al., 2009). The current studies add another, more subtle and fleeting, social cue that young children can rely on when evaluating potential partners: the genuineness of their smile.

The current work also adds important information to research on young children's understanding of smiles. Previous studies have shown that even very young infants prefer looking at a smiling, happy face rather than a fearful or neutral face (e.g., Farroni, Menon, Rigato, & Johnson, 2007), and that older infants can use others' positive versus negative facial expressions to decide how to react to a novel person or object (e.g., Walden & Ogan, 1988). The current studies go beyond investigating children's ability to discriminate and prefer faces with different expressions to show that, by around 3 years of age, children are becoming sensitive to much more subtle cues within positive facial expressions. Moreover, not only can they discriminate within positive facial expressions, but they can also link the genuine positive facial expressions to positive personal attributes (i.e., niceness and generosity) in a partner choice context. Thus these findings suggest that children might understand that there are social, as well as emotional, meanings behind facial expressions and that this information can be used to make social choices.

In summary, the current studies demonstrate that, when tested with simple methods, children can discriminate genuine and fake smiles and use them as social cues to evaluate others' cooperative potential. Children's ability to use these subtle social signals to make

inferences about others' generosity demonstrates an early sensitivity to one key honest, and thus evolutionarily relevant, signal of affiliative and cooperative intent. This ability can help children make appropriate choices when deciding with whom to interact.

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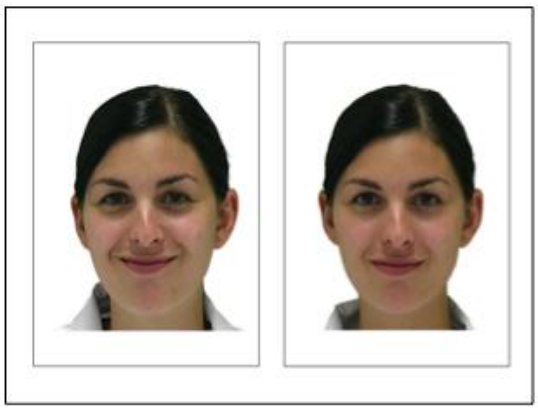
Figure 1. Picture stimuli presented in all the studies. Stimuli were taken from Miles and Johnston (2007), with permission. Here the genuine smile is always shown on the left side.

A)

B)

C)



D)

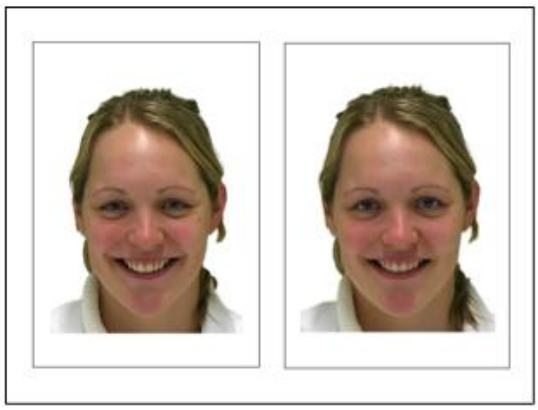
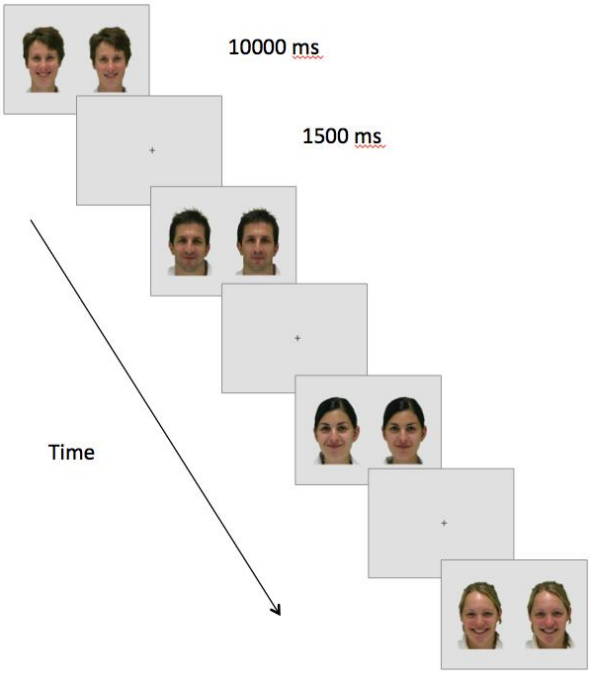
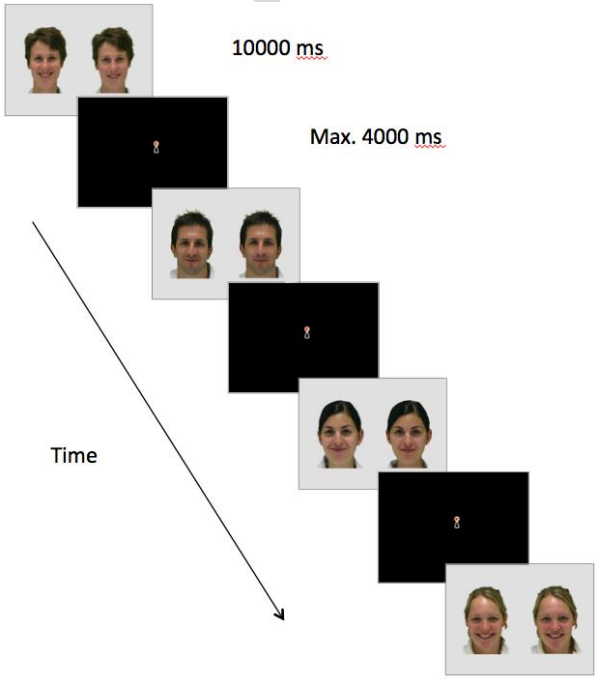


Figure 2. Stimuli presentation: a) eye-tracking procedure used in Study 3 with 3-year-old children; b) eye-tracking procedure used in Study 4 with 2-year-old children; c) example of the defined areas of interest (AOIs).

a)



b)



c)

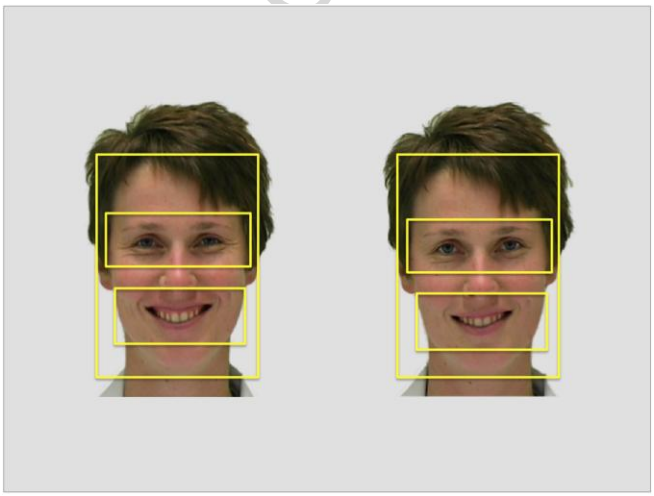


Figure 3. The relationship between age and children's tendency to infer prosociality from genuine smiles in Study 5.

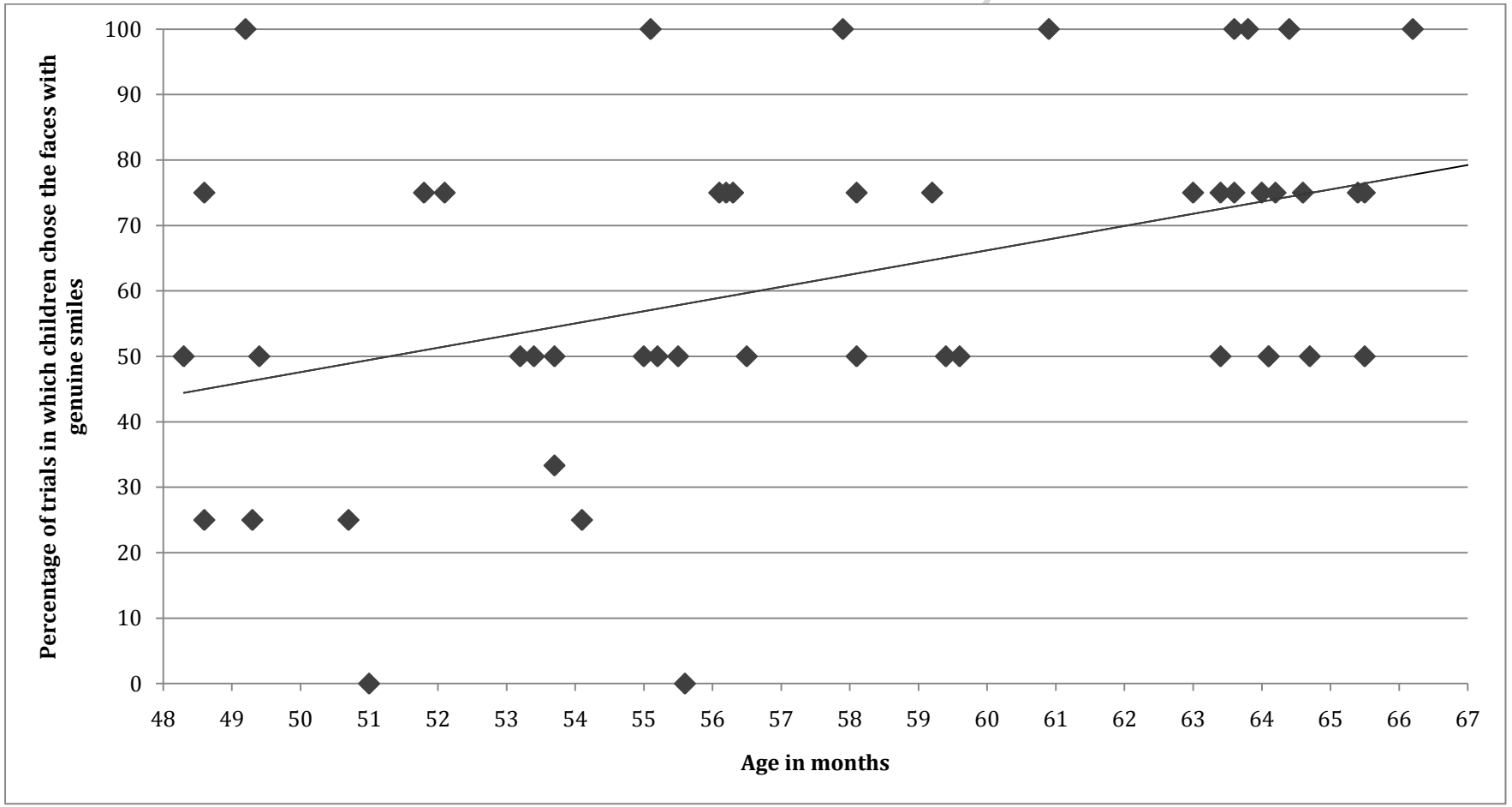


Table 1

Mean in milliseconds and percentage (with SDs) of fixation duration for each AOI (summed across all four face sets) from Studies 3 and 4.

Asterisk indicates that the result is significantly above the chance value of 50%.

	Fixation duration					
	Faces with genuine smile			Faces with fake smile		
	Face AOI	**Eye AOI**	**Mouth AOI**	**Face AOI**	**Eye AOI**	**Mouth AOI**
Study 3						
Eye-tracking test with 3-year-olds						
Mean	14159.3 (2488.6)	4244.5 (2555.3)	3066.3 (1938.6)	13178.0 (3426.2)	4152.5 (2697.0)	2806.5 (1988.1)
Percentage	52.3%* (4.9%)	30.1% (16.5%)	22.3% (15.6%)	47.6% (5.0%)	31.4% (17.8%)	21.8% (14.6%)
Study 4						
Eye-tracking test with 2-year-olds						
Mean	15768.1 (3026.3)	4499.6 (3019.6)	3594.4 (2442.3)	14816.0 (3087.9)	4313.6 (2876.0)	3110.5 (2271.8)
Percentage	51.6% (4.4%)	27.7% (18.7%)	24.6% (21.2%)	48.4% (4.4%)	28.4% (17.5%)	23.2% (21.5%)

Table 2

Summary of the hierarchical regression analysis predicting children's choice of the individuals with the genuine smiles as more generous in Study 5.

	***B* [95% CI]**	***SE*** $_B$	β	**ΔR^2**
Step 1				
Gender	22.20 [7.12 to 37.27]	7.46	.43* *	.16
Step 2				
Gender	22.03 [8.36 to 35.70]	6.76	.43* *	.31
Age	−1.88 [−3.09 to −0.66]	0.60	−.41* *	
Step 3				
Gender	22.27 [8.42 to 36.13]	6.85	.43* *	.30
Age	−1.88 [−3.11 to −0.66]	0.61	−.41* *	
ToM	−3.61 [−18.94 to 11.71]	7.57	.64	
Step 4				
Gender	22.85 [8.90 to 36.80]	6.89	.44* *	.30
Age	−2.42 [−4.12 to −0.72]	0.84	−.52* *	
ToM	−3.33 [−18.71 to 12.05]	7.59	−.06	
Gender x Age	1.13 [−1.34 to 3.60]	1.22	.17	
Step 5				
Gender	22.88 [8.71 to 37.05]	6.99	.44* *	.28
Age	−2.46 [−4.34 to −0.57]	0.93	−.53*	
ToM	−3.24 [−18.97 to 12.49]	7.76	−.06	
Gender x Age	1.14 [−1.37 to 3.64]	1.24	.17	
ToM x Age	0.13 [−2.80 to 3.07]	1.45	.01	

* * p <.01, * p<.05.